The effects of fractionated ethanol organosolv lignin on Ni/C-assisted depolymerisation at different temperatures

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INTRODUCTION

Lignocellulosic (LC) biomass, renewable and sustainable material, has increased intentions to develop greener procedures for the production of alternative fuels and selective valorization of high quality cellulose, hemicellulose and lignin streams. Lignin tackles initial depolymerisation due to the α-ether bond cleavage which was found to differ and depend on the solvents reactivity used during organosolv isolation process. Whereas, the content of β-ether bonds additionally depends on the pulping process (soda, kraft, organosolv, etc.) [1,2]. The process-related structural features of lignins (C-O and C-C bond content, molecular weight and hydroxyl group content) caused by fractionation process (Figure 1) and effects of reaction conditions have been investigated to draw correlations between the structural features and product distributions after lignin depolymerisation.

LIGNIN ISOLATION

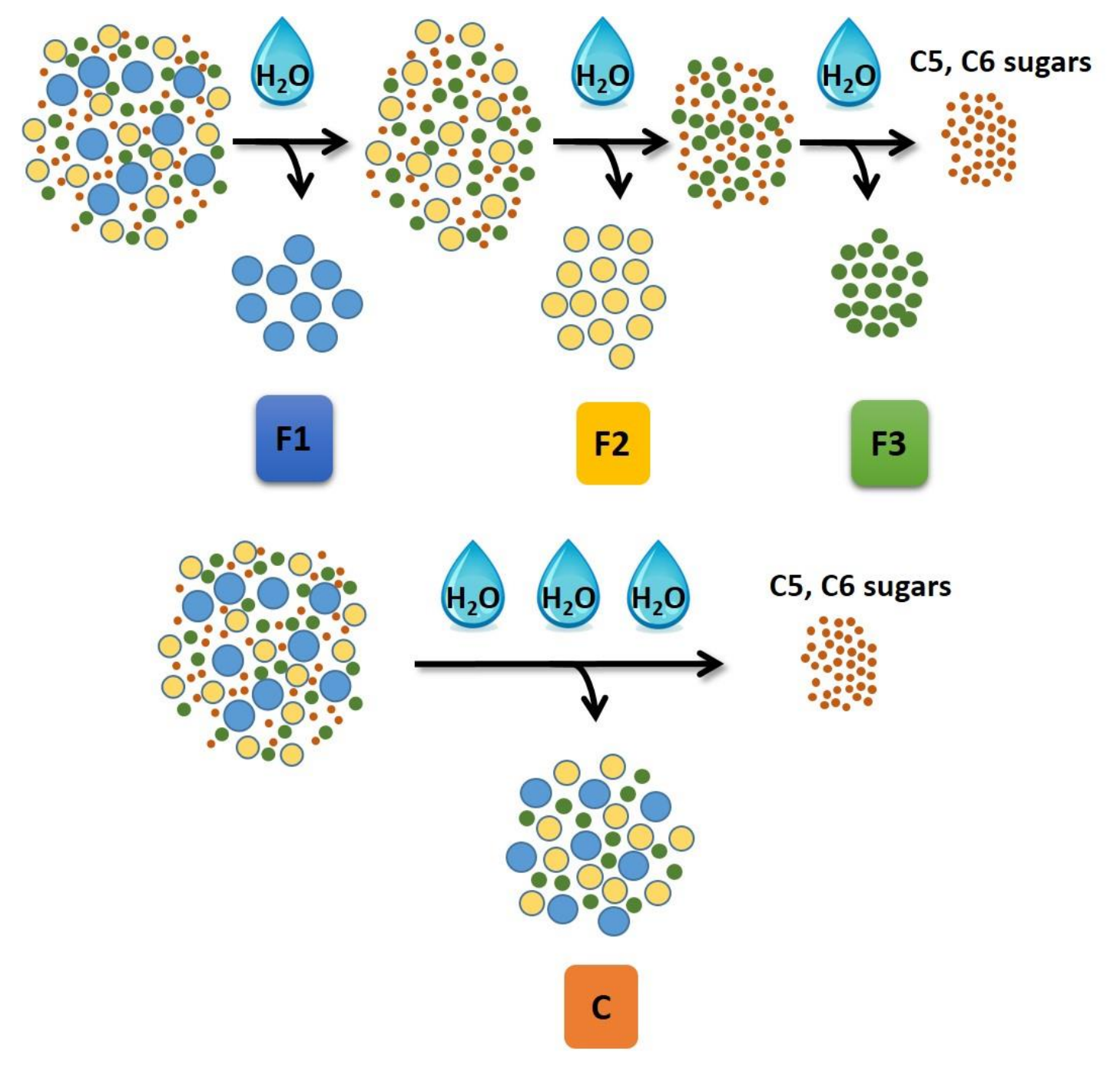

Figure 1: Fractionation protocol for lignin fractions and overall lignin isolation..

OBJECTIVES

Reductive depolymerisation has been applied for fractionated ethanol organosolv lignins (Figure 2). The product distribution of solid residue and oligomeric fragments (precipitated by acidification protocol) has been extensively analysed by SEC and NMR analytical techniques to evaluate the effect of lignin fractionation process on the efficiency/selectivity of lignin depolymerisation. Specifically, correlation between the distribution of the dominating reaction products and lignin structural features has been defined. Furthermore, the influence of the reaction temperature on the reaction product distribution has been evaluated.

(FRACTIONATED) LIGNIN DEPOLYMERISATION

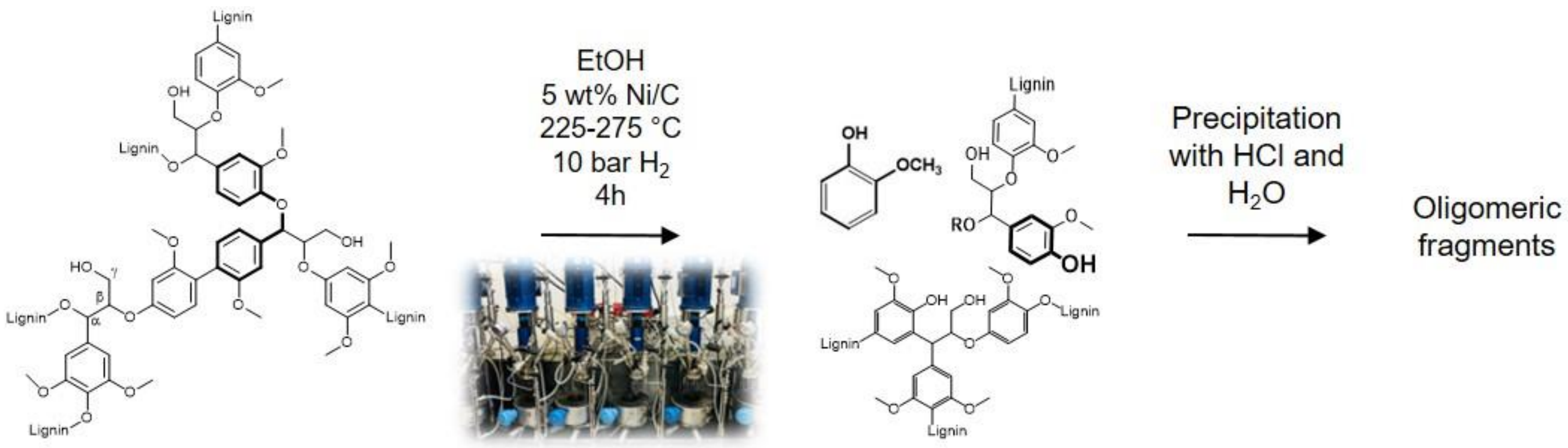

Figure 2: Experimental pathway for (fractionated) lignin depolymerisation.

STRUCTURAL FEATURES OF ISOLATED LIGNINS

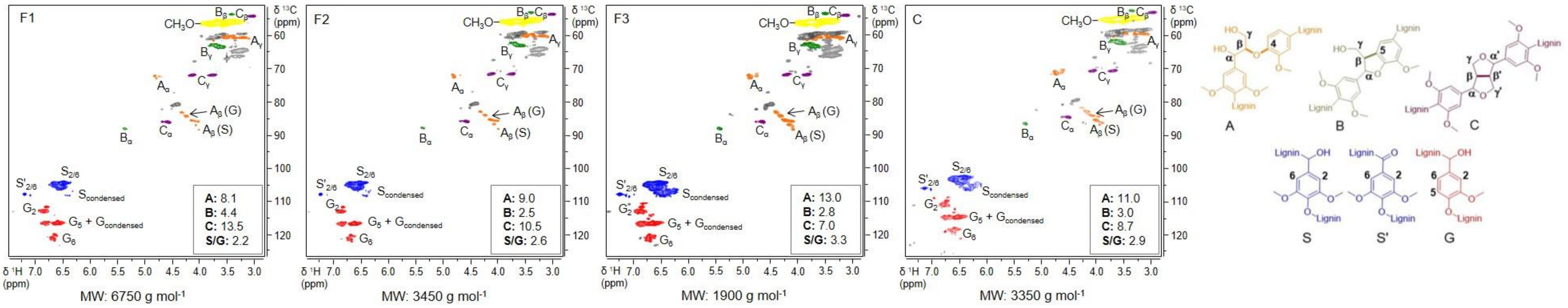

Figure 3: 2D HSQC NMR spectra of organosolv (C) and fractionated (F1-F3) lignins and its molecular weight (MW). F1 – the heaviest lignin fraction; F3 – the lightest lignin fraction.

RESULTS OF LIGNIN DEPOLYMERISATION

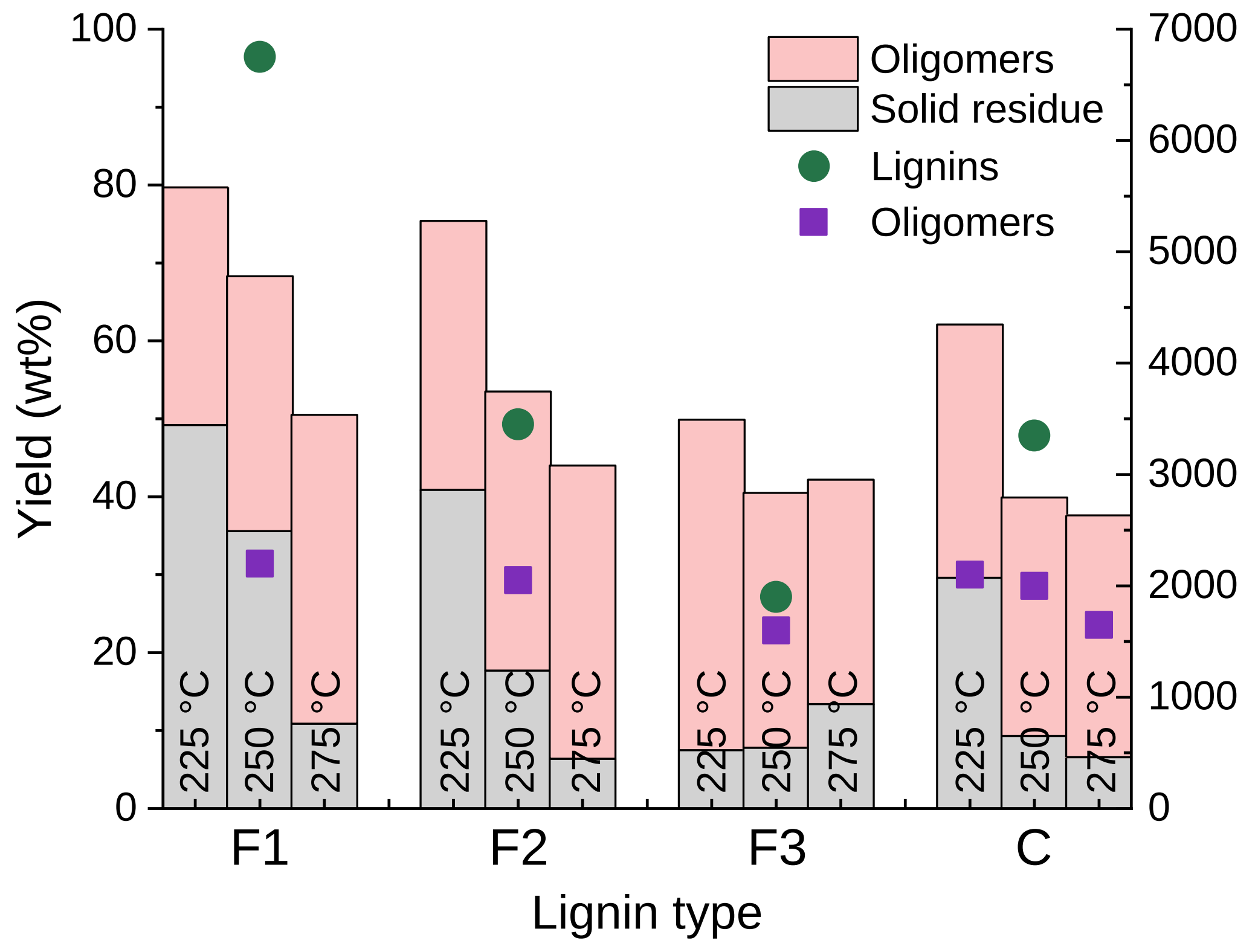

Figure 4: Effect of temperature and lignin structural features on product distribution with molecular weight of lignin and oligomer samples.

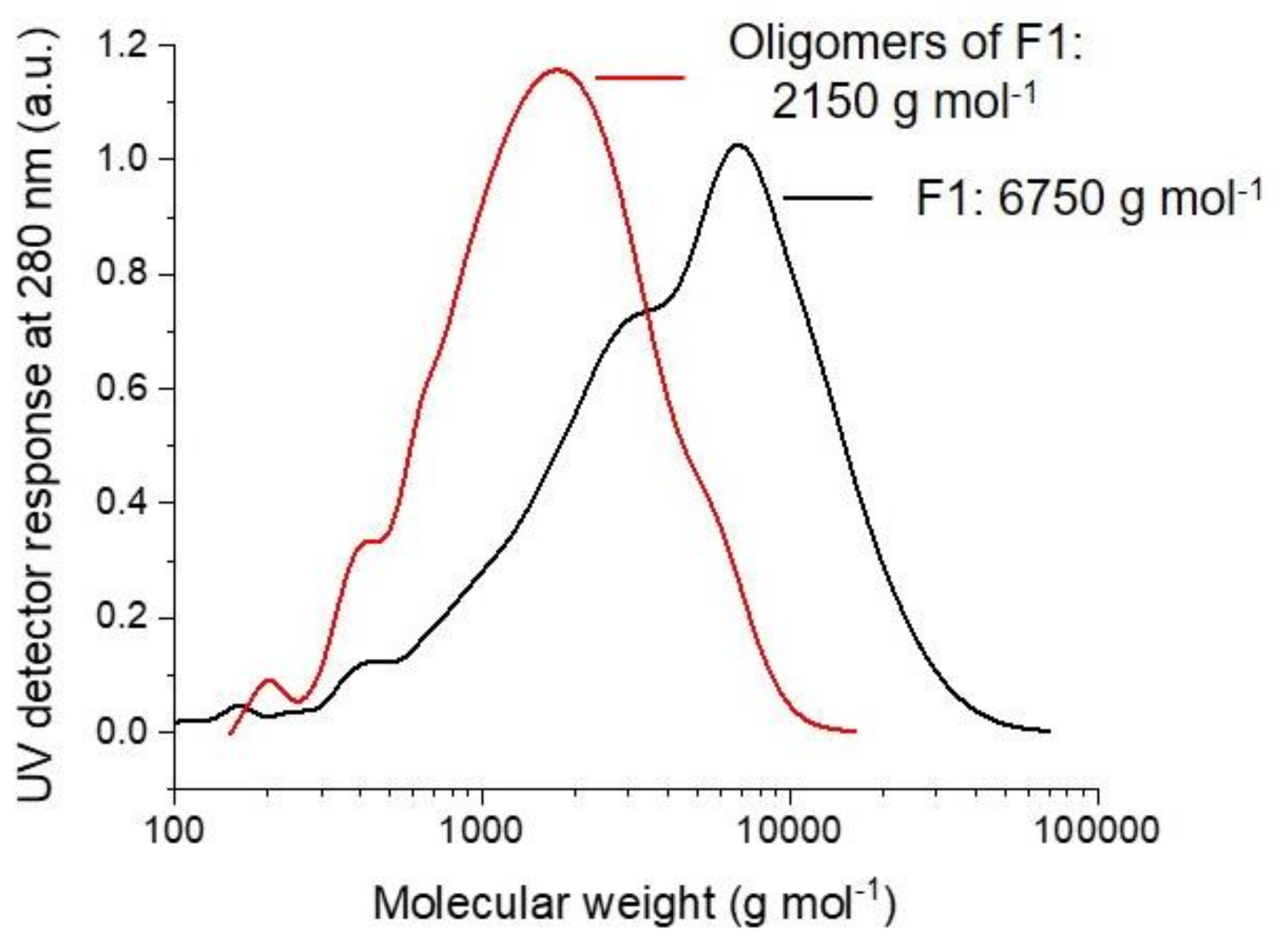

Figure 5: Comparison of MW for fractionated lignin sample (F1) before and after depolymerisation.

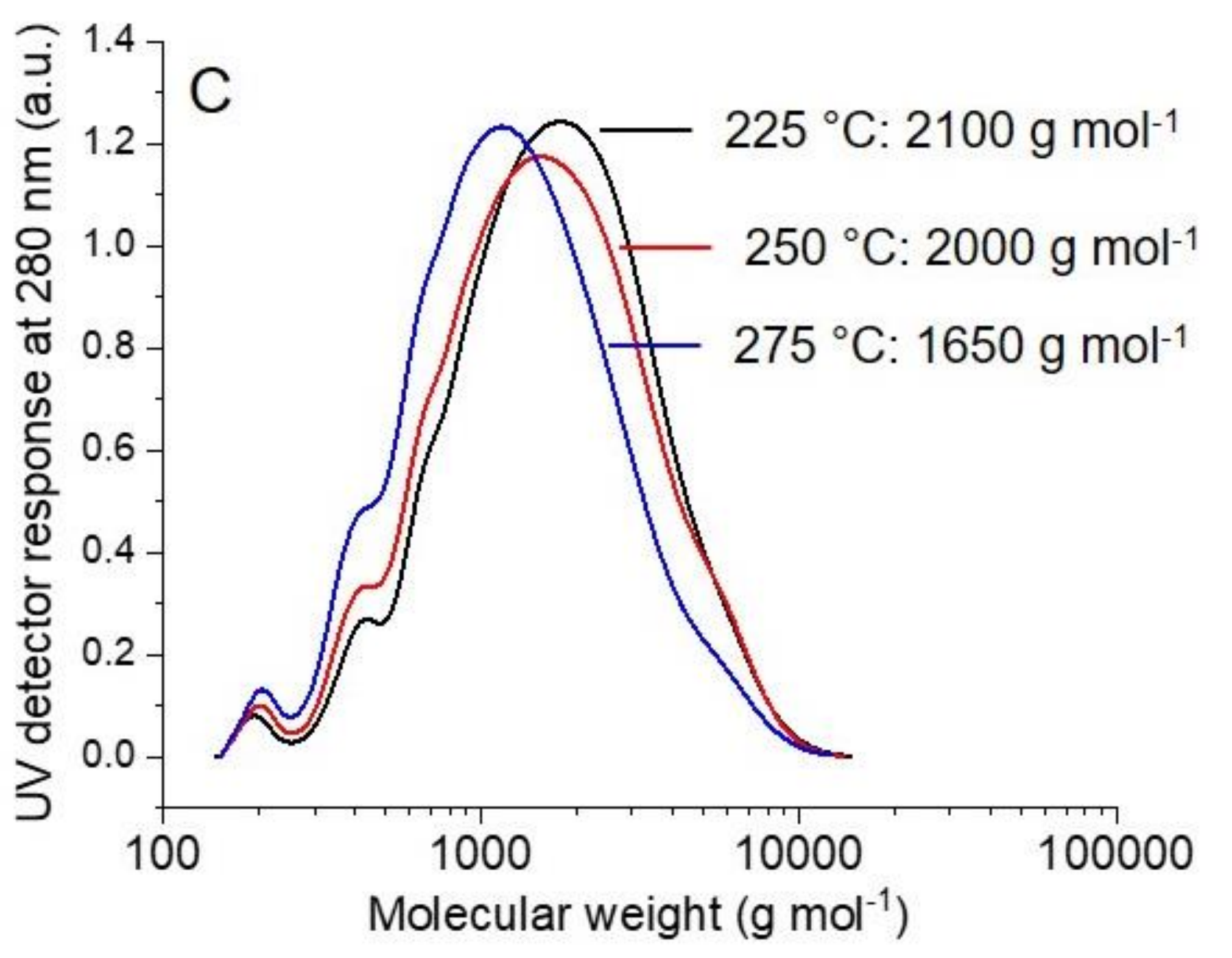

Figure 6: MW of precipitated oligomers of organosolv lignin (C) depolymerisation at different temperatures.

CONCLUSIONS

The yield of solid residue is proposed to follow linear correlation with increased MW of isolated and fractionated lignins while the structural features of lignins have not affected the amount of oligomers (Figure 4). Similarly, increased temperature affected in decreased formation of solid residue and negligible change in yields of oligomers (Figure 4). On the other hand, SEC analysis of fractionated lignin oligomers showed that temperature of depolymerisation effects on MW which was more reduced at higher temperature (Figure 4 and 6). Temperature depended structural features of depolymerisation products pointing toward the screening of reaction conditions is highly recommended with kinetically description of lignin depolymerisation process to successfully utilize lignin.

ACKNOWLEDGEMENTS

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