Synthesis of epoxy resin from cardanol derivatives

Luca Spruyt
Supervisors: Moctar Coulibaly, Christophe Minkenberg, Erik Rump, Qian Zhou
Project/Research Group: BBB&P
Contact information: 1064718@hr.nl
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Introduction

Cardanol is one of the main compounds found in Cashew Nutshell Liquid (CNSL), a waste product generated in cashew nut production[1].

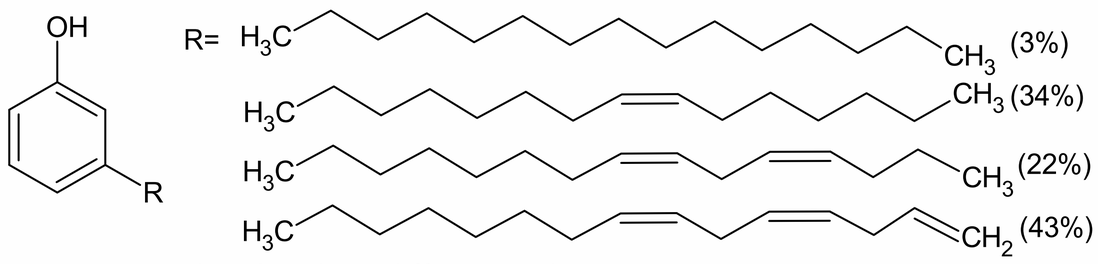

Figure 1: cardanol with its different tails

Cardanol can be epoxidized to produce bio-based epoxy resins. However, the limited number of double bonds in cardanol restricts the number of epoxy groups required for resin synthesis. In this project, cardanol ether was prepared with additional double bonds to increase the number of epoxy groups, aiming to enhance the resin's performance.

Method

- Allylation of cardanol on OH-group
- Epoxidation of cardanol with lipase
- Prepare epoxy resin
- Analysis: DSC, Gel content, recyclability

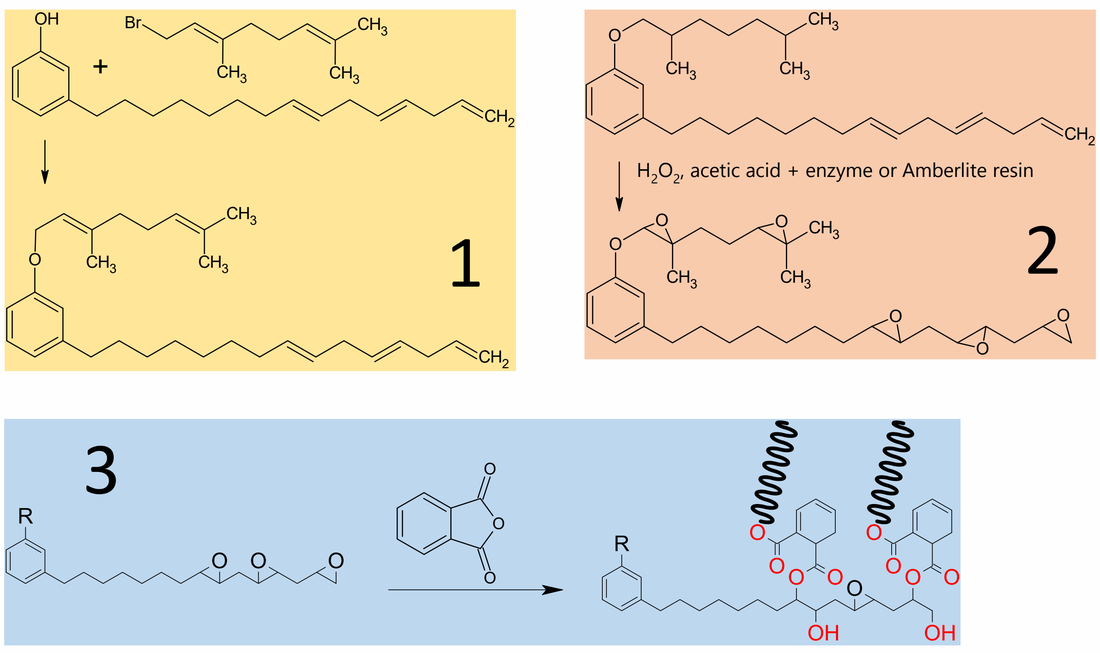

Figure 2 (1): Williamson ether synthesis of cardanol and geranyl bromide ; (2): epoxidation of cardanol ether. (3) reaction of epoxidized cardanol with crosslinker

[1]: Y.H. Kim et al. / Journal of Molecular Catalysis B: Enzymatic 45 (2007) 39–44

Results

Ether synthesis was performed with water as solvent and without solvent, with yields of 35% and 75-80% respectively. The solvent free-synthesis shows remaining OH-peaks, possibly caused by rearrangement of the product under heating

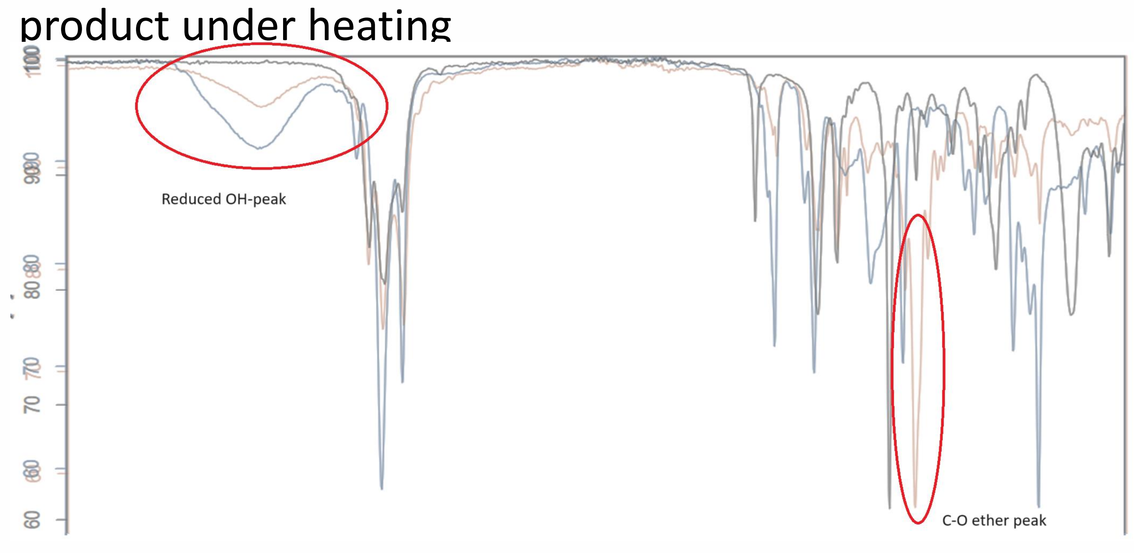

Figure 3: FTIR spectra of cardanol (blue), geranyl bromide (black) and the ether product (orange)

The epoxidation of the cardanol ether using amberlite resin yielded epoxide values up to 0,45 (~70% conversion.)

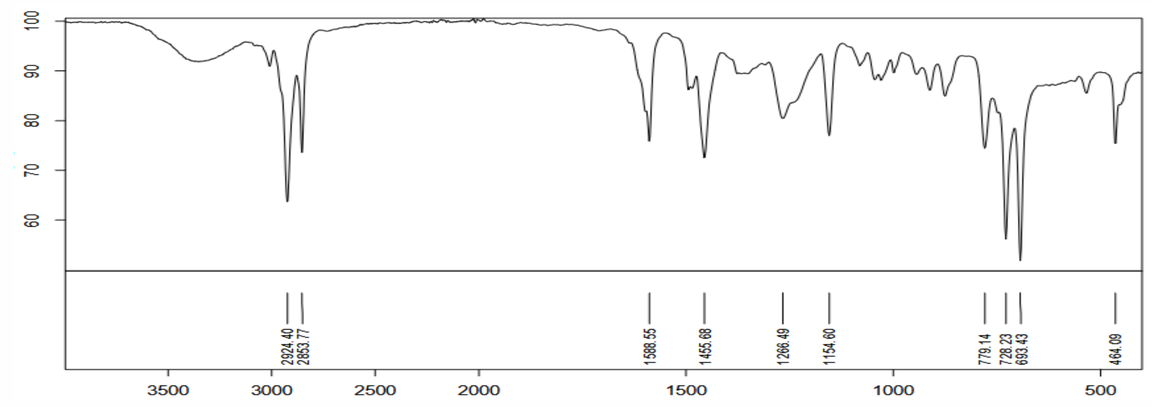

Figure 4: FTIR spectrum of epoxidized cardanol ether

The crosslinking of the cardanol epoxides with phthalic anhydride resulted in a transparent thermoset material (Figure 5) .

Figure 5: Thermoset material made with epoxidized cardanol ether and phthalic anhydride

Conclusion

Ether synthesis of cardanol can be performed without solvent at moderate temperatures (~60°C).

This product can be epoxidized using Amberlite ion exchange resin as a catalyst. An enzymatic method may also work, but more research is needed on preventing the enzyme deactivation.