Title: New Materials from Waste-Derived Fish Oil

Abstract:
Waste by-products from fish processing plants accounts for ~50 wt.% of the landed fish, and includes oil-rich heads, bones, and guts.\(^1\) Finding uses for this waste will increase sustainability in the fishing and aquaculture industries. Fish oils have the potential to be converted into commercially important products, including epoxides, cyclic carbonates, and polyurethanes, using environmentally benign and non-toxic reagents. Epoxidation of fish oil was optimized using a method previously explored for soybean oil epoxidation.\(^2\) In the current research, monounsaturated oils (methyl oleate and oleic acid) were used as test substrates and epoxidized with conversions of around 80%. Waste salmon oil was also epoxidized, giving 94% conversion to the epoxide, with 3.9 epoxy groups per triglyceride. Using catalytic tetrabutylammonium bromide the epoxidized fish oil (EFO) could be converted to the corresponding fish oil carbonate (78% conversion, 110 °C and 10 bar CO\(_2\)). Using tetrabutylammonium bromide with ascorbic acid as a co-catalyst the conversion to carbonate was increased to 90%. \(^{1}\)H and \(^{13}\)C NMR spectroscopy, infrared spectroscopy, thermogravimetric analysis, and differential scanning calorimetry were used to characterize EFO and fish oil carbonates. The fish oil-derived cyclic carbonates were then reacted with an environmentally sustainable cashew nutshell liquid-derived amine to form polyurethanes. Infrared spectroscopy was used to confirm the formation of polyurethanes. Aqueous degradability of polyurethane films was performed in both salt and deionized water, showing increased water absorption in deionized water. The polymers produced, as they will be 100% bio-derived, may show an enhanced biodegradability over traditional petroleum-based materials. We plan to perform further degradation studies on the formed films, as well as characterize their mechanical properties.

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