Bio-based replacements to fossil fuel plastics

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BPA is an organic compound made from fossil fuel sources. The industrial chemical has been used to make plastics and resins since the 1950s, and products made with it are cheap to make, clear, flexible and strong. BPA can be found in a variety of products, including water bottles, storage containers and sports equipment. It's also widely used in

the linings of food and beverage cans and in sales receipt paper. It's one of the most commonly synthesized chemicals today with more than six million tons created in 2018 alone.

However, studies since 2008 have shown that BPA mimics estrogen in the body and has negative impacts on our endocrine systems. Some retailers have withdrawn products made with BPA and the search for BPA-free plastics has led to research along similar alternatives such as bisphenol S and bisphenol F. But the safety of these fellow fossil fuels alternatives is still unknown.

Dean Webster, professor and chair of coatings and polymeric materials; Mukund Sibi, University Distinguished Professor of chemistry and biochemistry; and NDSU chemistry and biochemistry doctoral candidate Catherine Sutton recently published research on bio-based alternatives to bisphenol-A (BPA) in the American Chemical Society's *Sustainable Chemistry and Engineering* journal. The research is titled "Novel Biobased Furanic Diols as Potential Alternatives to BPA: Synthesis and Endocrine Activity Screening."

The NDSU team set out to create BPA alternatives that were derived from biomass feedstocks versus fossil fuels. They created a series of new diols (organic chemistry building blocks) from readily available feedstock material hydroxymethyl furfural (HMF). HMF is an organic compound formed by the dehydration of certain sugars. It's found naturally when sugar-containing feedstocks are heated and caramelization occurs. It occurs naturally in coffee, dried fruit and honey as well as byproducts like high-fructose corn syrup.

Analysis of the new diols for endocrine activity and cytotoxicity was performed and three HMF-based diols were identified given their lack of negative affect on endocrine activity. These potential replacements for BPA are now being evaluated in the NDSU laboratories for their

applications in coatings and polymers.

"These diols have a high potential as starting material for a number of polymeric materials," said Sutton. "We are optimistic as we move forward with polymerizations using our biomass-derived diols." By finding natural diols that did not have the same negative biological reactions as BPA, the team's research is unique.

"Finding replacements for bisphenol-A is a big deal these days," Sibi said. "We have made new safer diols that have been initially assessed for their biological activity, which really sets our work apart from others in the field. We believe we have an alternative to BPA that is safe and doesn't rely on fossil fuels, which is an added benefit." Funding was provided by the ND Center of Research Excellence (CORE) Biobased Materials Science and Technology (BiMAT) and supported through in-kind and financial contributions of AkzoNobel. The project also was supported by the ND EPSCoR Center for Sustainable Materials Science.

More information: Catherine A. Sutton et al. Novel Biobased Furanic Diols as Potential Alternatives to BPA: Synthesis and Endocrine Activity Screening, *ACS Sustainable Chemistry & Engineering* (2020). DOI: 10.1021/acssuschemeng.0c08207

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