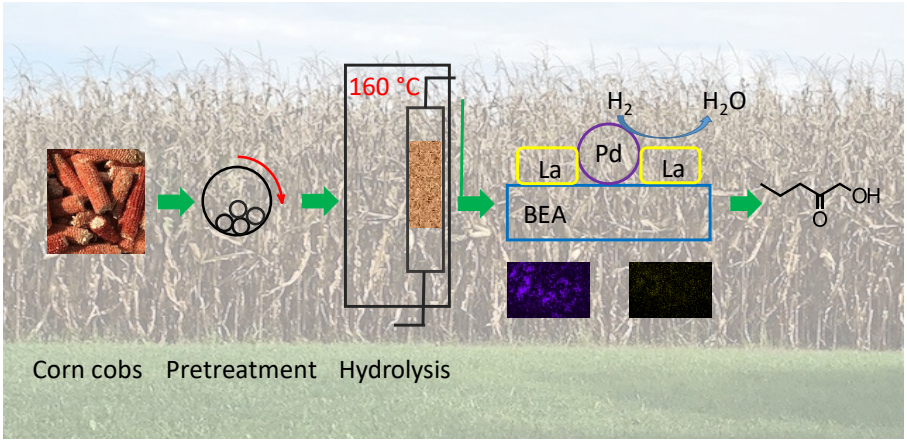
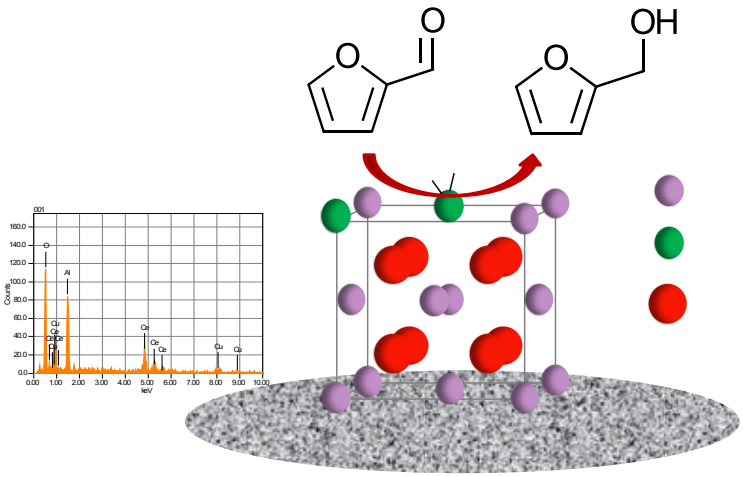
Chemicals from corn cobs



This work demonstrated that a new sustainable chemical can be prepared from corn cobs, thereby increasing the value of crop residues. Expansion of the rural economy depends on growth in the biorefinery sector, which will lead to increased job growth in these areas. Biorefiners will benefit from this work by having a larger number of products that can be sold and corn growers will benefit from having a greater demand for their crop residues. This chemistry is important to the research community because it is the first demonstrated chemical conversion of corn cob to a valuable compound.

Jackson, M. A., Price, N. P. J., Blackburn, J. A., Peterson, S. C., Kenar, J. A., Haasch, R. T., and Chen, C. Partial Hydrodeoxygenation of corn cob hydrolysate over palladium catalysts to produce 1-hydroxy-2-pentanone. Appl. Catal. A.: Gen. 577:52-61. 2019.

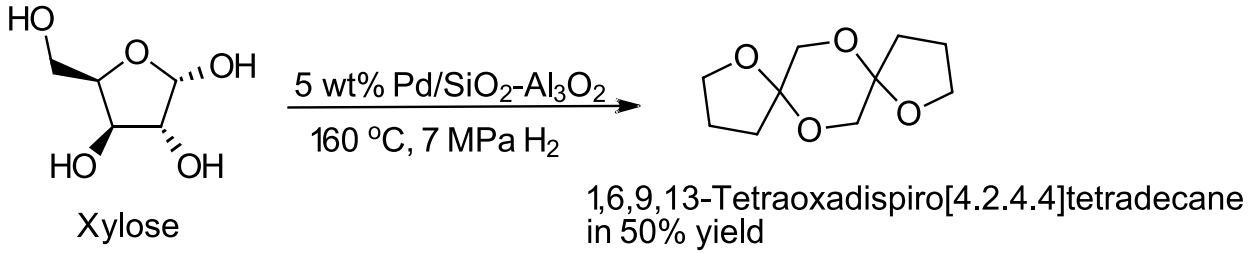
Hydrogenation of furfural over the dynamic CuCe oxide surface



This work was undertaken to increase the value of crop residues by expanding the number of products and improving the efficiencies at which they can be produced at a biorefinery. Biorefineries can utilize crop residues in a supply chain that isolates the sugar xylose which in turn is converted to furfural. This compound is then treated with hydrogen to give the marketable product furfuryl alcohol. This reaction requires a catalyst and it is the performance of the catalyst that determines if the reaction is commercially viable. The catalyst we developed is comparable in performance to that currently used in industry but works without toxic chromium in its make-up. Continued development of catalytic conversions of biomass will aid in the expansion of biorefineries which contribute to rural economic opportunities.

Jackson, M. A.; White, M. G.; Haasch, R. T.; Peterson, S. C.; Blackburn, J. A. Hydrogenation of furfural at the dynamic Cu surface of $CuOCeO_2/Al_2O_3$ in a vapor phase packed bed reactor. *Molecular Catalysis*, *445*, 124-132. 2018.

A new compound from the sugar xylose



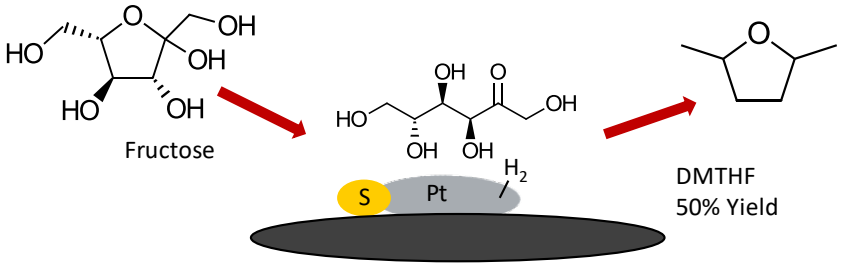
Xylose

1,6,9,13-Tetraoxadispiro[4.2.4.4]tetradecane in 50% yield

In this work we have demonstrated that the common sugar xylose can be converted to a series of useful compounds. One of these, 1,6,9,13-tetraoxadispiro(4.2.4.2)tetradecane, has a fragrance that is described as being similar to hazelnuts or bourbon, which means it could possibly be used as a food additive. We also converted this to a compound that has the capacity to inhibit an enzyme known to exacerbate a host of health problems associated with metabolic syndrome, including hypertension, obesity, and insulin resistant diabetes. This project was initially undertaken to explore routes to industrially useful chemicals from agricultural waste. A portion of this waste is the sugar xylose.

Jackson, M. A.; Blackburn, J. A.; Price, N. P. J.; Vermillion, K. E.; Peterson, S. C.; Ferrence, G. M. A one-pot synthesis of 1,6,9,13-tetraoxadispiro(4.2.4.2)tetradecane by hydrodeoxygenation of xylose using a palladium catalyst. *Carbohydr. Res.*, *432*, 9-16. 2016

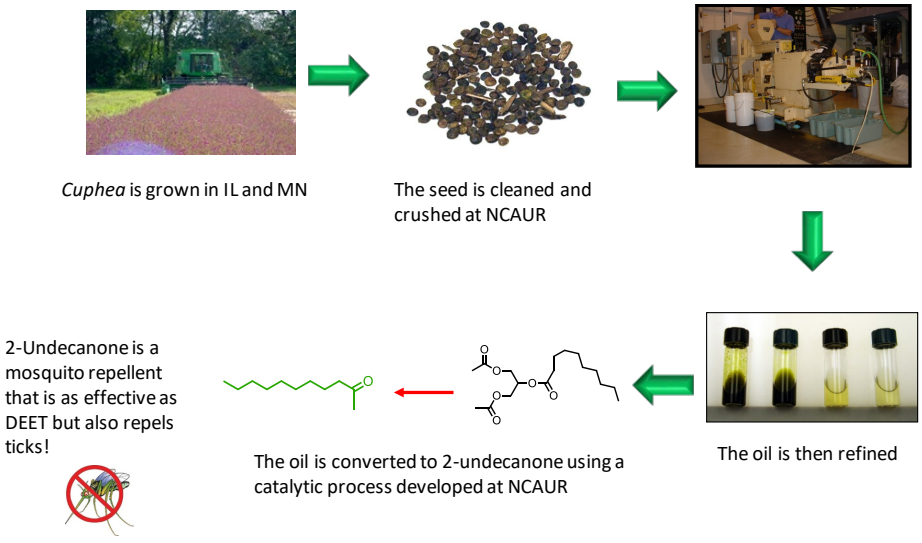
Hydrodeoxygenation of fructose to make a fuel additive



In this work we demonstrated a simple conversion of sugar to the fuel component DMTHF. A second generation biofuel, DMTHF has properties that are better than ethanol, such as being insoluble in water, that make it attractive. What we found in this work is that if the proper catalyst is used for the conversion of the sugar fructose, yields of DMTHF can be quite high. The commercialization of this technology will lead to greater use of crop residues or energy crops for production of a renewable chemical with uses as a solvent or fuel additive.

Jackson, M. A.; Appell, M.; Blackburn, J. A. Hydrodeoxygenation of fructose to 2,5-dimethyltetrahydrofuran using a sulfur poisoned Pt/C catalyst. *Ind. Eng. Chem. Res.*, *54*, 7059-7066. 2015

<u>Production of an insect repellent from a new crop: *Cuphea*</u>



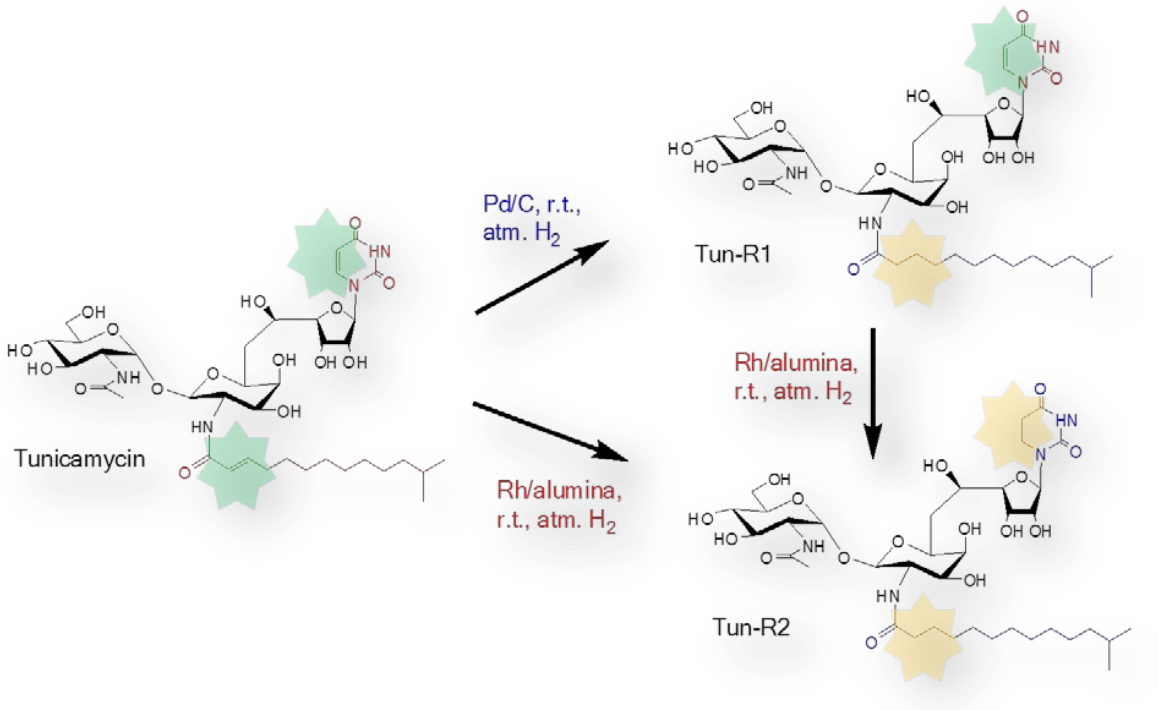
In this work we demonstrated that a sustainable supply of the fragrance compound 2-undecanone can be prepared from the oil obtained from *Cuphea* seed oil. 2-Undecanone not only is the fragrance of

rose, it repels insects as well as DEET and repels ticks. *Cuphea* is a row crop under development for growing on marginal land in the upper Midwest. Its seed oil is high in medium chain fatty acids and would serve as a palm oil substitute. Using our process, which reacts acetic acid with the oil, an acre of *Cuphea* would produce 160 lbs of 2-undecanone.

Jackson, M.A. and Cermak, S.C. Cross ketonization of *Cuphea* sp. oil with acetic acid over a composite oxide of Fe, Ce, and Al. *Appl. Catal., A Gen*., *431–432*, 157-163. 2012.

Selective hydrogenation of the antibiotic Tunicamycin

The tunicamycins are potent antibiotics isolated from soil bacteria, but cannot be used clinically because of their toxicity. The ARS scientists have previously reported that chemically-reducing the tunicamycins make them considerably less toxic. Importantly, these less toxic tunicamycins, called Tun R1 and Tun R2, maintain their potent antibacterial activities. The present paper describes new ways to produce Tun R1 and Tun R2 using catalytic hydrogenation. Selective catalysts have been found that can efficiently convert tunicamycin into either Tun R1 or Tun R2. The hydrogenations are a significant improvement on previously reported chemical reductions and can be readily scaled up. This work is of value for animal and human novel treatments of bacterial infections.



Price, N.P.J., Jackson, M. A., Vermillion, K. E., Blackburn, J. A., Li, J., Yu, B. Selective catalytic hydrogenation of the N-acyl and uridyl double bonds in the Tunicamycin family of protein N-glycosylation inhibitors. J. Antibiot. 70:1122-1128. 2017.