# Synthesis of Renewable Surfactants

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**ABSTRACT:**
Herbicides such as Roundup® are used to kill unwanted plants. These products utilize glyphosate as the active ingredient and were previously believed to be carcinogenic and related to cancer development. Multiple carcinogenicity studies have been carried out and numerous regulatory agencies have determined that the data does not support a link between glyphosate and cancer.[1] However, it has been reported that surfactants, another ingredient in common herbicides, are more toxic than glyphosate itself.[2] Surfactants are used to overcome solubility problems and to facilitate the dispersal of molecules in a solution. In order to create herbicide products with less toxicity to humans, new surfactants are being synthesized and researched.[2] The aim of this research project is to create non-toxic surfactants using green and renewable resources such as natural carbohydrates and fatty acids. The resulting surfactants will be characterized, and their properties tested with the goal of creating less toxic, natural, and renewable surfactants to be used in products like Roundup®.

**INTRODUCTION:**
Three different carbohydrates were used to provide the polar head group for the target surfactant. A non-polar fatty acid tail will be added to the head group in future reactions.

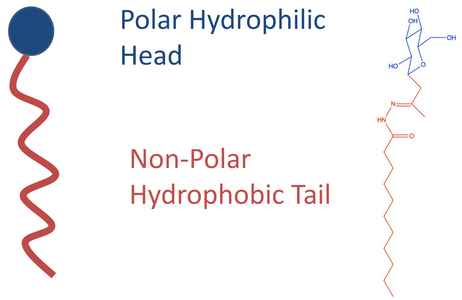
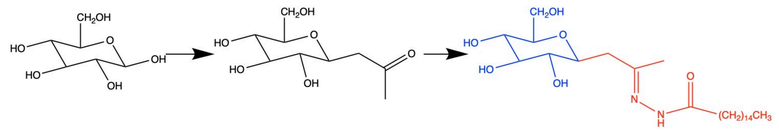
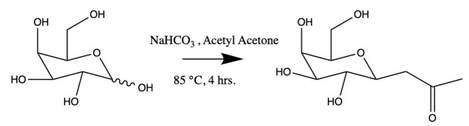



**Figure 2:** A chemical structure of a general surfactant (left) and a diagram of a surfactant (right) with the polar hydrophilic head group (blue) and the non-polar hydrophobic tail (red) labelled.

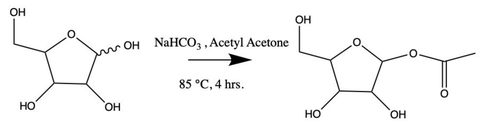
**Scheme 1.** General scheme for synthesizing a renewable surfactant from D-glucose. Note that glucose could be substituted by a variety of different carbohydrates.



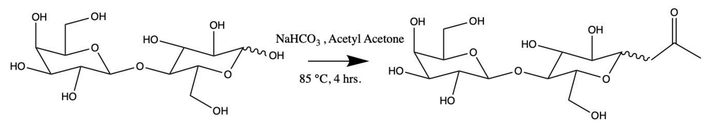
**Scheme 2.** General scheme for the synthesizing a *C*-galactoside ketone from D-galactose.




**Scheme 3**. General scheme for synthesizing a C-xyloside ketone from D-xylose.




**Scheme 4**. General scheme for synthesizing lactoside ketone from lactose.




**RESULTS AND DISCUSION:**
In **Figure 1.** the stacked $^{13}C$ NMR is depicted. There was a consistent peak present at approximately 212 ppm which indicates the presence of a ketone. The peak also suggests that the experimental products are consistent with proposed reaction schemes.

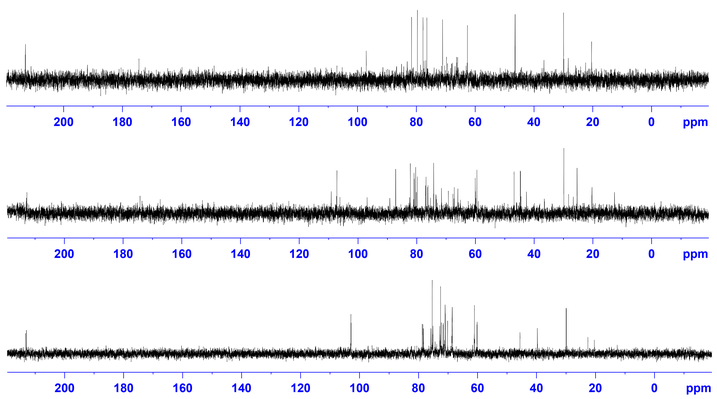



**Figure 1:** Stacked $^{13}C$ NMR of glycoside ketones using D-galactose (top), D-xylose (middle), and lactose (bottom).

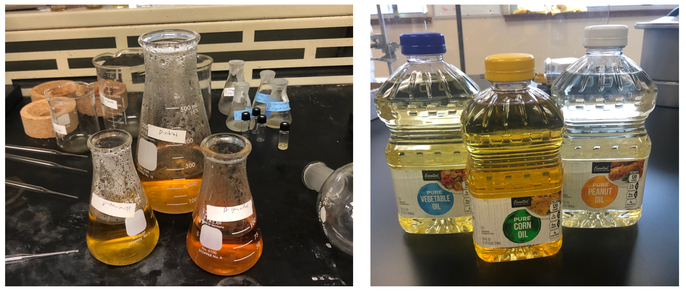


**Figure 2:** Image of reaction mixtures of the polar head groups (left) and picture of natural oils used to synthesize the fatty acid tails (right).

**FUTURE DIRECTIONS:**
Future reactions will be required to add non-polar fatty-acid tails to the head groups. Those tails could be derived from natural oils such as peanut or vegetable oils. The subsequent renewable surfactants will be characterized. The novel character could be associated with with unique aspects of each surfactant and reveal how and why surfactants perform in the way they do. This would lead to breakthroughs in surfactant synthesis and provide a pathway to control and direct renewable and non-toxic surfactant synthesis for specific performance characteristics.

**ACKNOWLEDGMENT:**
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**REFRENCES:**
(1)Portier, C.J. A comprehensive analysis of the animal carcinogenicity data for glyphosate from chronic exposure rodent carcinogenicity studies. *Environ. Health.* **2020,** *19*, 0-19
(2)Mesnage, R.; Benbrook, C.; and Anoniou, M.N. Insight into the confusion over surfactant co-formulants in glyphosate-based herbicides. *Food and Chem. Toxicol.* **2019,** *128*, 137-145
(3)Holmberg, K. Natural surfactants, *Curr. Opin. Colloid Interface Sci.* **2001**, *4,* 148-159,