Siberian elm samaras: a natural source with potential for sustainable aviation fuel

A lipidomics study revealing the presence of medium-chain triglycerides

[1] Chandler J. Seaton, [2,3] Chloe D. White, [2] Olivia G. Williamson, [2] Saracyewski A.M. Smith

[1] Department of Biological and Agricultural Engineering, College of Engineering, Agricultural Technology Management, Kansas State University, [2] Division of Environmental Science, College of Arts and Sciences, , Kansas State University, [3] Department of Education, College of Education, Educational Studies, Kansas State University

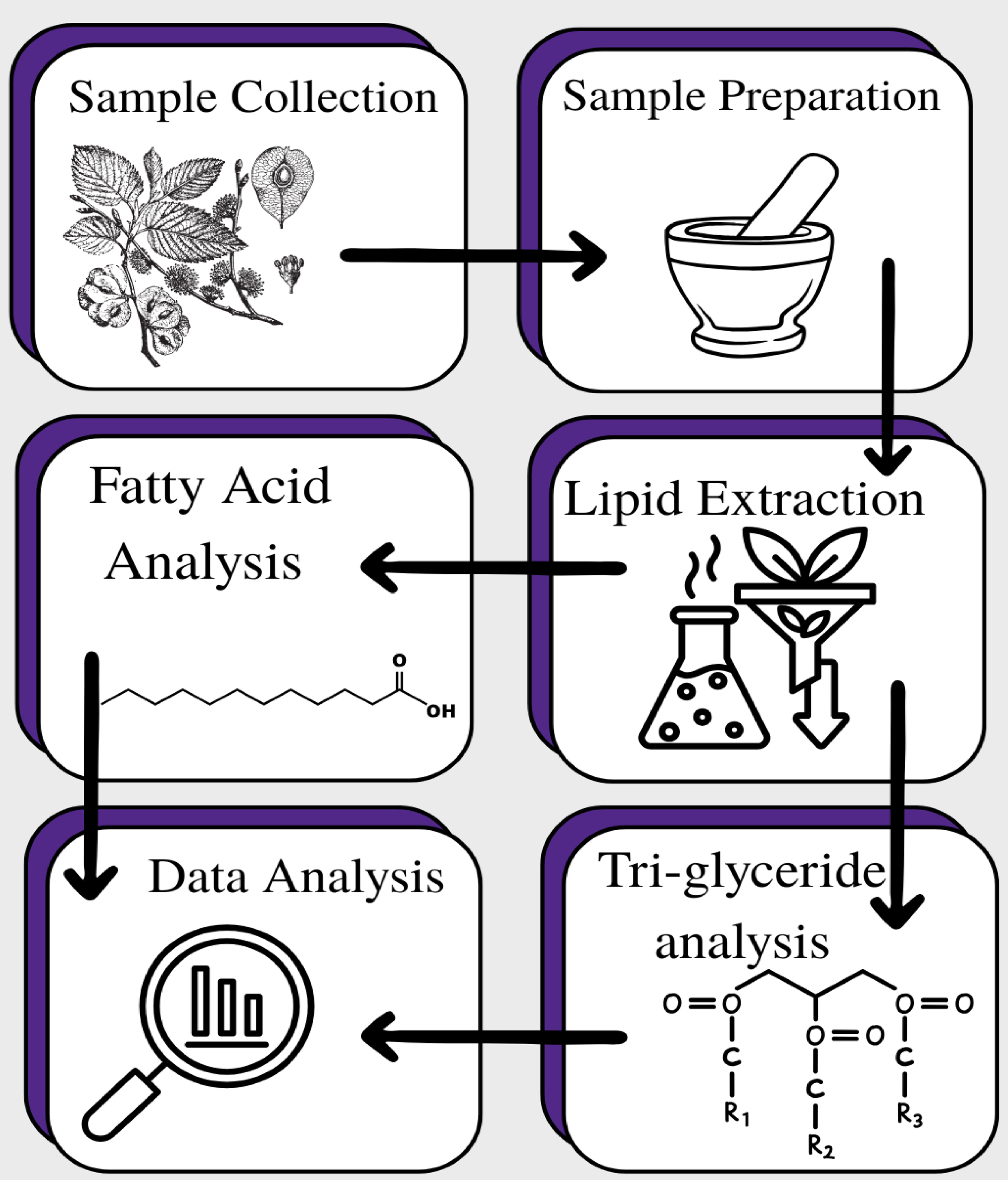
Introduction

Sustainable Aviation Fuel (SAF) offers a renewable alternative to petroleum-based jet fuels, playing a vital role in reducing aviation-related carbon emissions. As a drop-in fuel, SAF is compatible with existing aircraft infrastructure, and one promising feedstock source is plant-derived oil rich in medium-chain triglycerides (MCTs), which contain medium-chain fatty acids (MCFAs; C8–C14). Recent bioengineering efforts have aimed to enhance MCT content in cover crops, but these transgenic lines often underperform, highlighting a need for naturally resilient alternatives. Despite its reputation in the U.S. as an invasive species, *Ulmus pumila* (Siberian elm) is widely used for erosion control and windbreaks—and may serve another purpose: a novel source of MCT-rich oil. Preliminary data from the Plant Fatty Acid Database suggests high MCFA content in this genus. Capitalizing on Siberian elm's prolific seed production, our research focused on analyzing MCT content in its samaras. Using Electrospray Ionization Mass Spectrometry (ESI-MS/MS) and Gas Chromatography-Flame Ionization Detection (GC-FID), we examined 21 samples—buds, flowers, and samaras collected at various time points. Our findings indicate high levels of MCTs in the samaras at the last time point (Figure 2), underscoring their potential as a sustainable bio-jet fuel feedstock. This work also supports the genetic potential of Siberian elms for future crop engineering efforts aimed at sustainable energy solutions.

Question

1. Do Siberian elm (*Ulmus pumila*) samaras accumulate significant levels of MCFAs?
2. During samara development, which stage produces the highest MCT levels?

Methods



Results

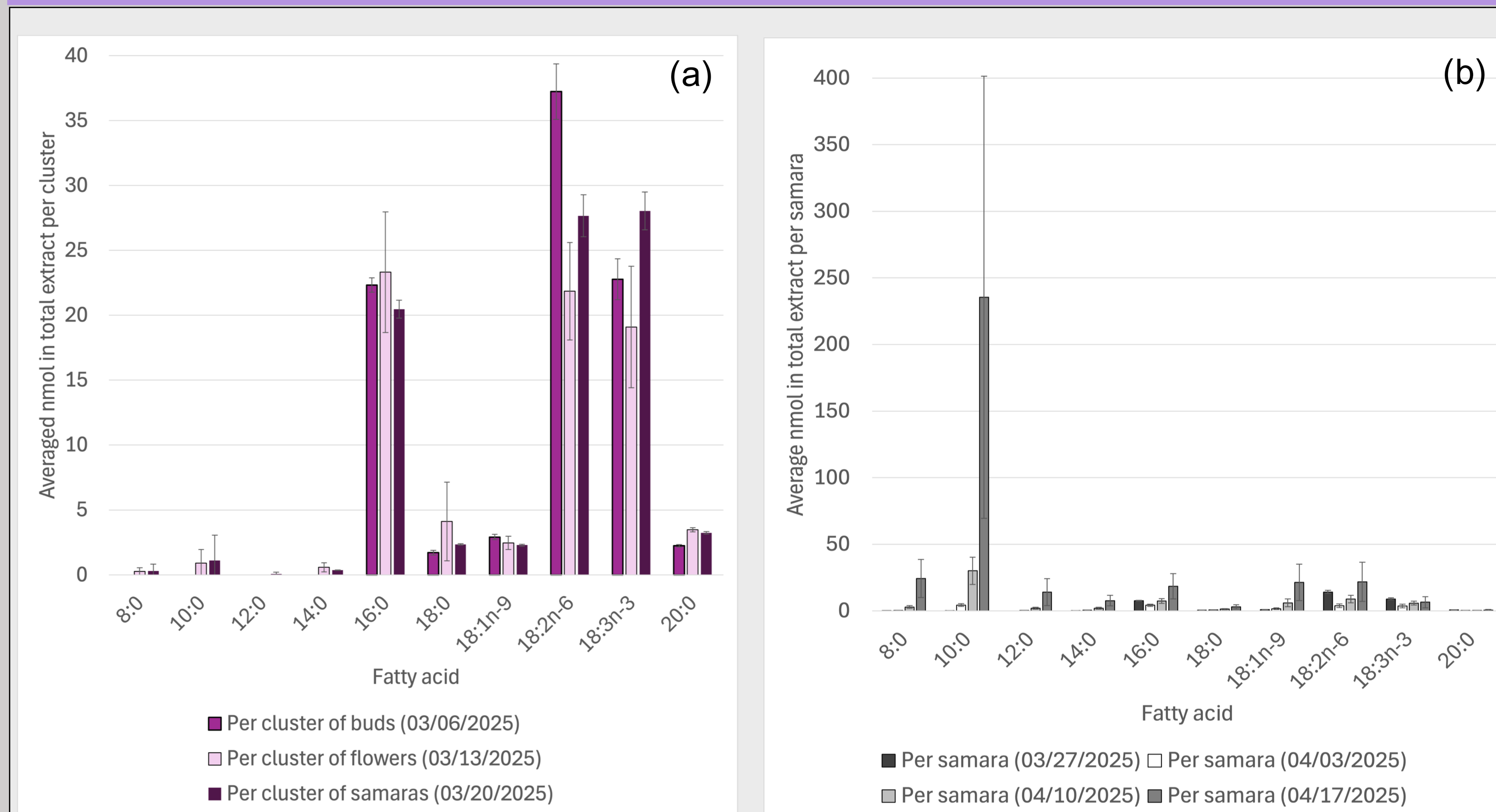


Figure 1: Fatty acid data through samara development. (a) Average nmols of fatty acids per cluster of buds (03/06/25), flowers (03/13/25), and young samaras (03/20/25) (b) Average nmols of fatty acids per samara (03/27/25, 04/03/25, 04/10/25, 04/17/25)

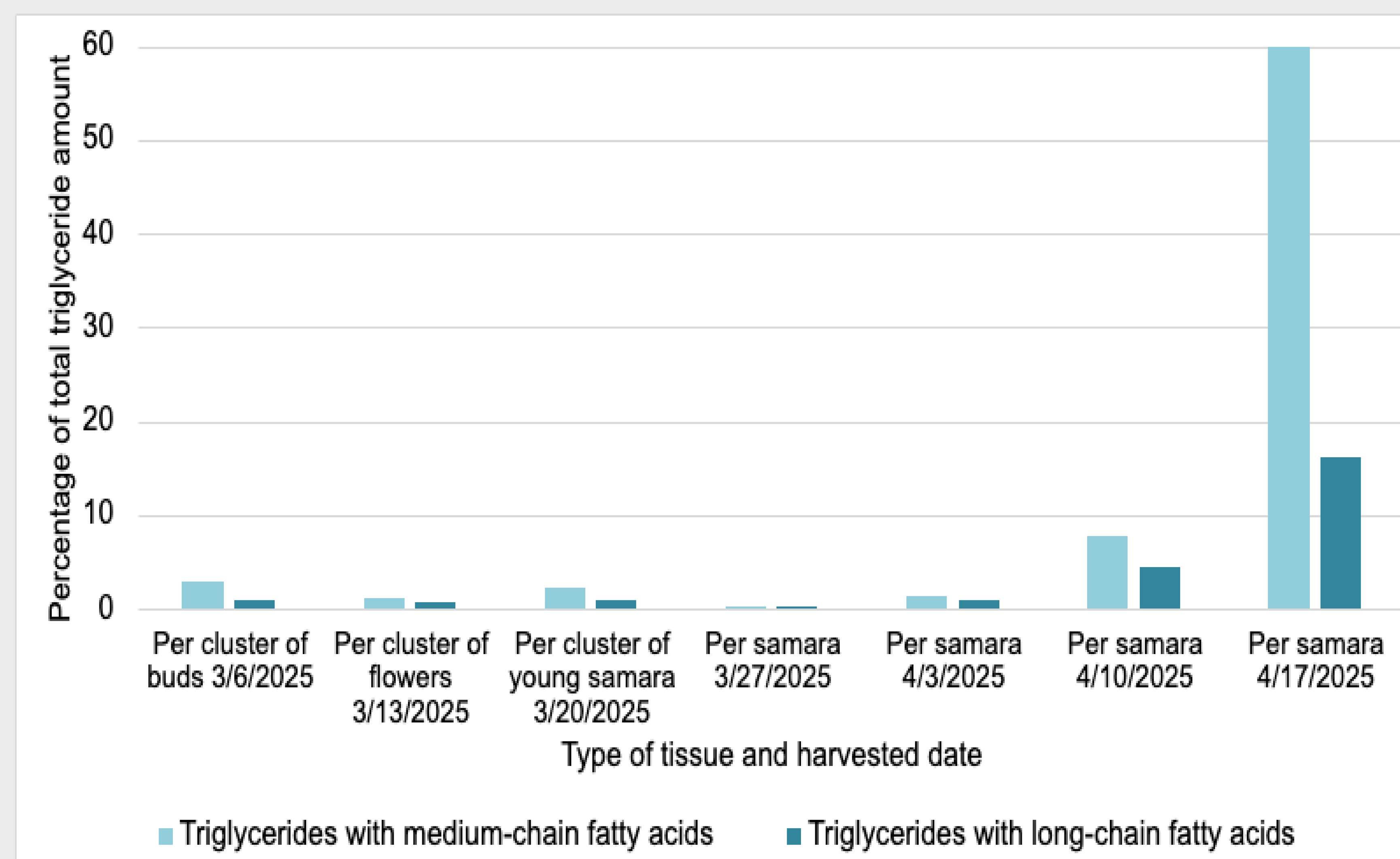


Figure 2: Triglyceride amounts as percentages over samara development

Figure 3: Timeline of samara development. (a) a cluster of buds (03/06/25), (b) a cluster of flowers (03/13/25), and (c) a cluster of young samaras (03/20/25), (d) a samara (03/27/25), (e) a samara (04/03/25), (f) a samara (04/10/25), (g) a samara (04/17/25). (a)-(d) microscopic figures (e)-(g) camera photos.

Future Directions

1. Evaluate the physical properties of the oil and assess its compatibility with existing engine systems.
2. Identify the genes responsible for oil production and transfer them into a suitable cover crop. This approach not only supports sustainable fuel production but also offers agricultural benefits—such as improving soil moisture retention and organic matter—making it attractive to commercial farmers seeking effective cover crop solutions.

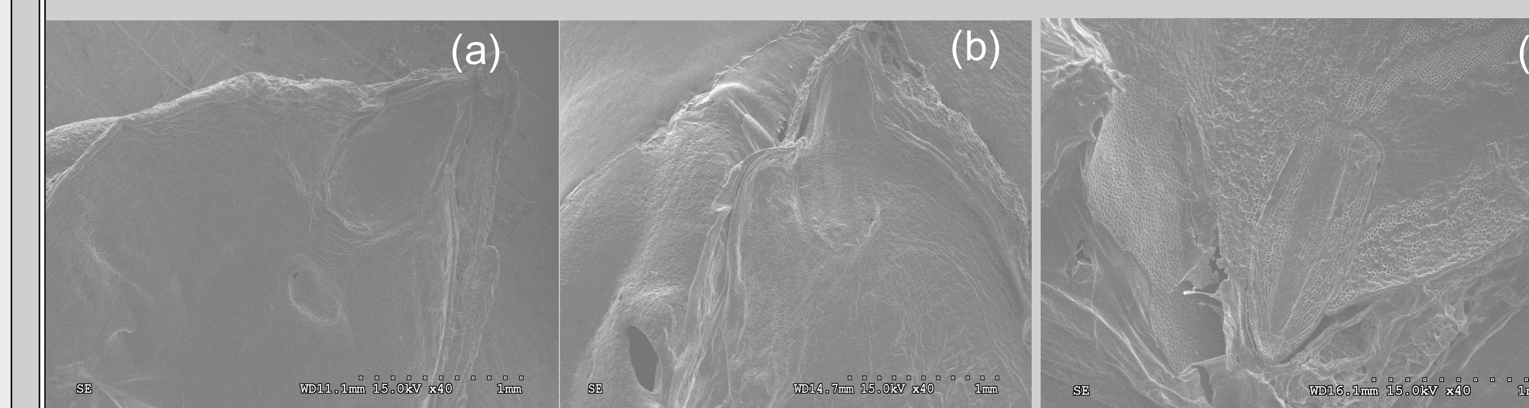


Figure 4: Scanning Electron microscope images of embryo of Siberian elm seed at x40 magnification. (a) 04/3/2025 (b) 4/10/2025 (c) 4/17/2025

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Conclusions

1) During Samara development, at the latest stage they have the most medium-chain triglycerides.
2) Flowers and pods do not have high medium-chain fatty acid levels compared to samaras.
3) 4/17/2025 has the most triglycerides with medium chain fatty acids.

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