Nutrient Analysis of Hazelnut Kernels

Overview

A central goal of the Upper Midwest Hazelnut Development Initiative (UMHDI) is to produce improved varieties of both interspecific hybrid and American hazelnuts. Early selection has focused on key agronomic traits including yield, kernel size and shape, cold tolerance, and Eastern Filbert Blight (EFB) resistance. In the next phase of breeding, our aim is to also incorporate traits related to kernel quality. This summary covers the following topics:

1) Nutritional trait data related to the quality of hybrid and American hazelnuts
2) Development of a predictive model for nutrient content in hazelnuts using near infrared (NIR) spectroscopy

Measurement of Nutritional Traits

Hazelnuts harvested in 2023 and 2024 were analyzed using laboratory methods to measure kernel moisture, protein, total oil, oil composition, and total phenols. Figure 1 shows a species-level comparison between American (*Corylus americana),* European *(C. avellana),* and interspecific hybrid (*C. americana x C. avellana*) hazelnut plants across seven nutrient traits and kernel cross-section area. These data show that American hazelnuts have higher oil content, lower total phenol content, and smaller size than hybrid hazelnuts. We also observe significant variability across individual plants of both American and interspecific hybrids, which provides a promising starting point for breeding efforts to select for improved nutritional quality.

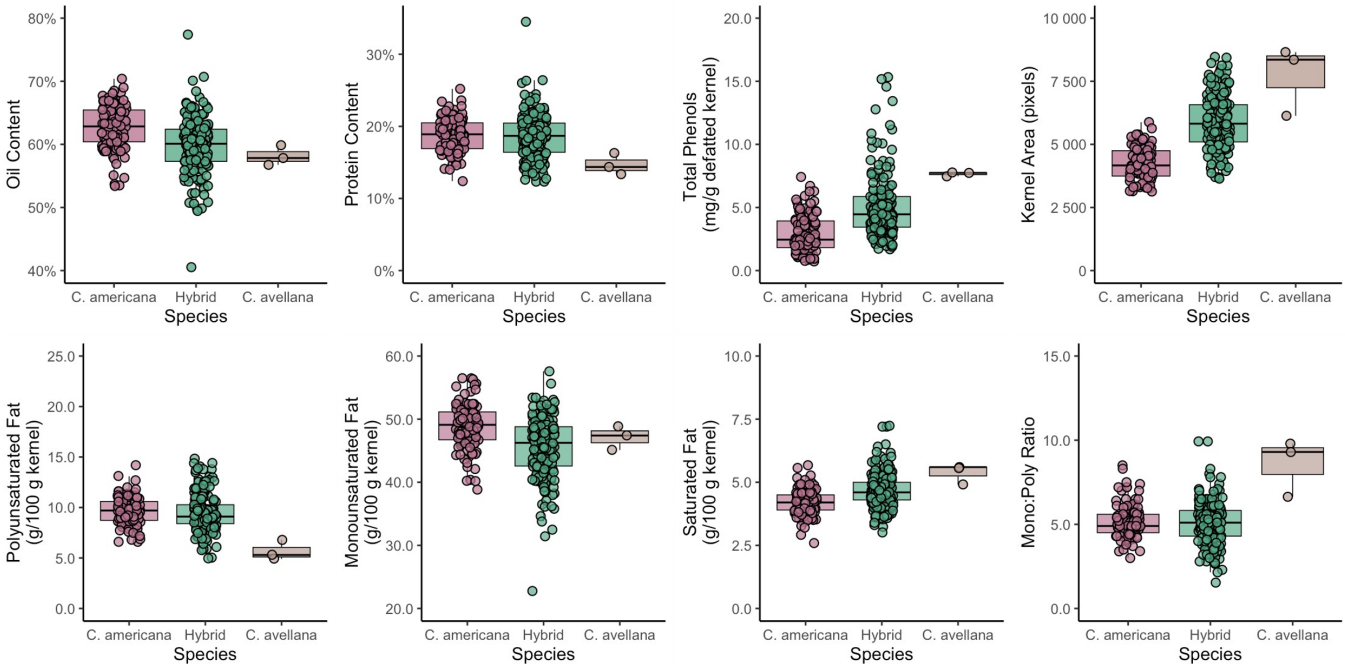

Figure 1: Top: Species-level comparison of oil, protein, phenols, and kernel cross-section area. **Bottom:** Comparison of oil composition: polyunsaturated, monounsaturated, saturated, and monounsaturated:polyunsaturated ratio.

Traits can vary due to both genetic and environmental factors. Comparing different locations across multiple years can reveal environmental effects. In Figure 2, the oil and protein content of three Adventure series cultivars (Adventure, Cache, and Forager) are shown for four locations in the 2024 harvest. Protein content varied significantly by both cultivar (Adventure > Cache & Forager, $p < 0.05$) and by location (West Madison > Spring Green & St Paul; Rosemount > St Paul, $p < 0.05$). Oil content, on the other hand, did not vary significantly by either cultivar or location in 2024.

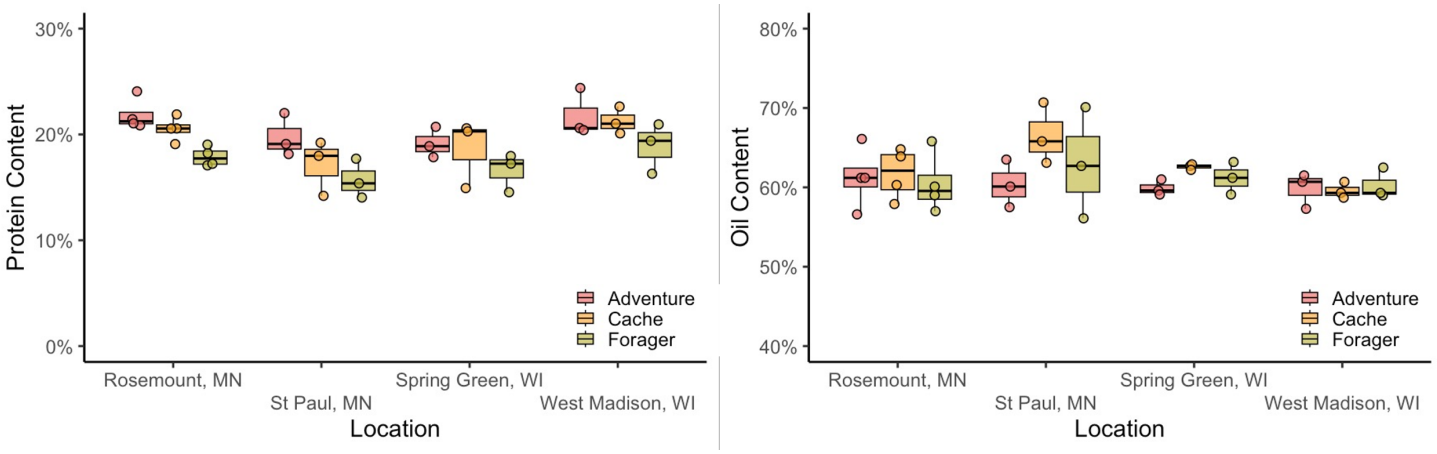

Figure 2: Protein and oil content by cultivar and location in 2024 samples.

Development of a Near-Infrared Predictive Model

Laboratory methods to analyze nutrient traits are labor- and resource-intensive; measuring these traits each year for the hundreds of samples in our breeding population is not feasible. Near-infrared (NIR) spectroscopy is a fast and inexpensive method in which a specialized camera measures how much infrared light is absorbed or reflected by a sample. The NIR spectrum obtained from imaging is correlated to the types of chemicals present in the sample (such as proteins or fatty acids). By pairing lab analysis and NIR measurements, we can build a statistical model that predicts the nutrient content of future hazelnut samples using only NIR data, allowing us to measure enough samples to select for nutritional quality traits in our breeding program. Our work shows that NIR data can reliably predict many of the chemical traits reported above (Figure 3).

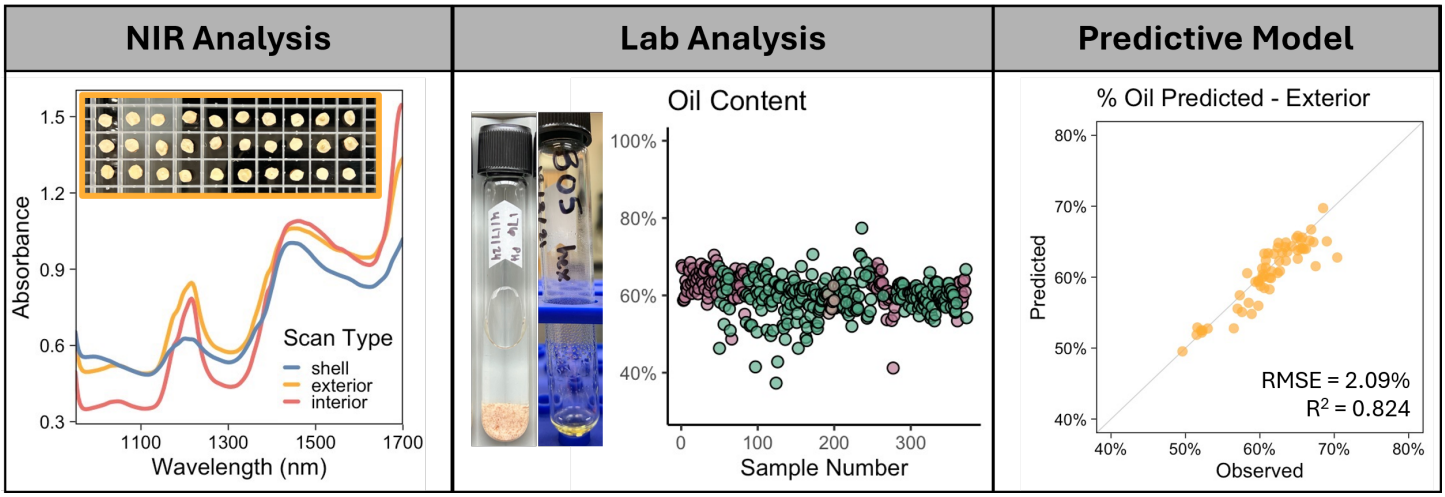

Figure 3: Samples are analyzed using NIR spectroscopy (left) and lab methods (middle). A statistical model predicting the lab values from the NIR values is built (right). Traits for new samples can then be estimated using NIR data alone.

Future Outlook

The NIR models developed in this project will be applied to guide the selection of hazelnut progeny for breeding. In the longer term, these NIR models may become accessible to growers to evaluate the quality of their own plants. Predictions of nutritional quality can also be combined with genomic models to uncover genetic markers for desirable traits. Measurement of additional quality traits, such as the link between oil composition and oil shelf life, is currently ongoing.

Dr. Peyton Higgins, Addison Konlan, Prof. Julie Dawson, Prof. Brad Bolling. Thanks to Marissa Nix, Tessa Peters and Ava Glaser. Funding provided by USDA-NIFA AFRI Plant Breeding Program 2023-67013-39614

UPPER MIDWEST HAZELNUT DEVELOPMENT INITIATIVE

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