Winter Oilseed Quarterly Update #10: Winter Oilseeds: A New Alternative for Plant Based Proteins

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Demand for plant proteins is growing at rapid pace due to the rising demand in food and beverage products for high protein meat alternatives, cereals, snacks, and nutritional supplements. While many leguminous plants, like peas and soybeans, are known to be a good source of protein based on their high levels of seed storage proteins (SSPs), some Brassica species also have protein compositions that can be used in food products. For example, canola (*Brassica napus*) is second largest oil producing crop with ~45% oil content and ~25% SSPs. Canola contains cruciferin (60%), sulfur-rich napin (20%), and other minor proteins (including oleosins and lipid transfer proteins). This mix of proteins gives canola a balanced amino acid profile compared to leguminous protein sources such as soybean[1]. However, several anti-nutritional factors, such as glucosinolates, phytic acid, fiber, sinapates, and nonstarch polysaccharides (NSP), are among the non-desirable compounds present in canola meal which makes it unsuitable for human consumption[2]. Recent developments in canola have removed the anti-nutritional compounds and made the meal edible[3].

Pennycress and winter camelina are related Brassica species that are being domesticated for use in the Upper Midwest as cash cover crops. Both species contain high protein content. Field pennycress proteins are uncharacterized, but some reports suggest that protein composition is comparable to the existing plant-based proteins[4]. Similarly, camelina proteins have a huge potential in industrial and food applications due to its gelling and emulsification properties[5]. The Ismail lab in the Department of Food Science at the University of Minnesota initiated a program to understand the use of pennycress and camelina proteins in food applications in 2014. The initial research has been on the wild forms of these crops that have not undergone selection for protein quality. Preliminary analysis suggests that some modifications to the protein composition in pennycress and camelina will make the protein meal more attractive to food and beverage manufacturers. In pennycress, breeding for these changes can take advantage of the one-to-one gene correspondence with the model plant Arabidopsis[6]. Also, genes involved in the synthesis, accumulation and regulation of accumulation of SSPs have been studied in the Arabidopsis. This knowledge could be further utilized to bring the desired changes in the pennycress seed protein[7]. Using traditional mutation breeding methods, the pennycress genomics and breeding team, led by the Marks lab at the University of Minnesota, has identified pennycress lines with variation

in total protein content. Some of these lines were then assessed using gel-based and mass-spectrometry methods to determine if the lines were also different in protein type and composition (Figure 1). Altered, missing, or new protein bands in these lines suggest that the amino acid composition has been altered and could demonstrate increased proportion of cysteine, lysine, or methionine like essential amino acids. Genetic control for these changes remains to be identified in pennycress. Once identified, this information will be transferable to camelina and other oilseeds to increase their use as a protein source for food and beverage products.

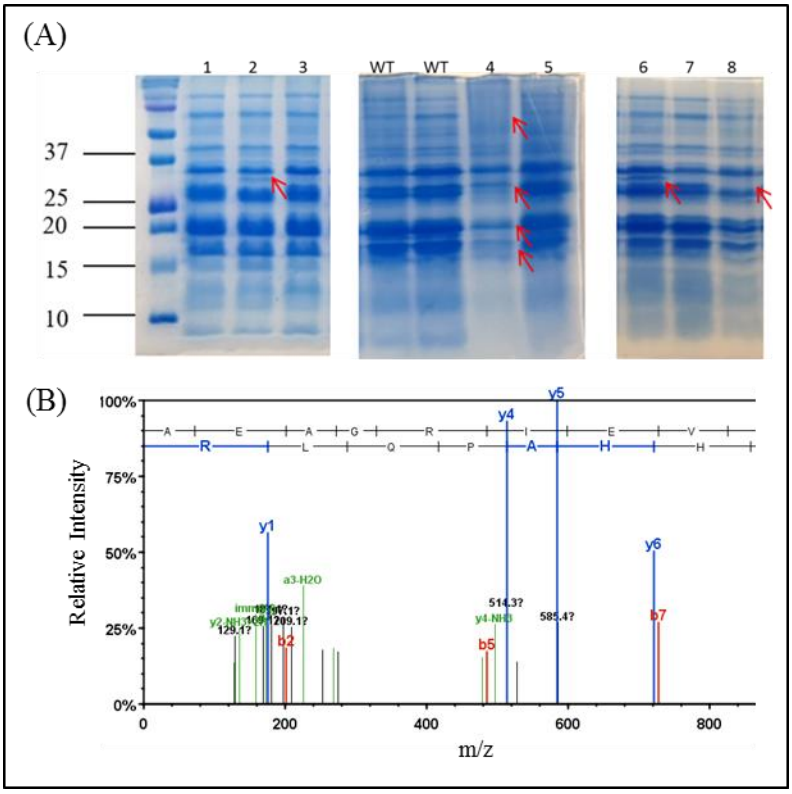

Figure 1: Pennycress seed protein analysis for the identification altered protein content or composition. (A) Seed protein extracted from various pennycress lines (labeled 1-8) was compared with wild type pennycress (labeled WT) using gel based methods. Red arrows indicate alteration/missing/new protein bands that suggest differences in protein composition. (B) Protein identification in wild-type pennycress using mass-spectroscopy.

References

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