Chemical Characterization of the Perennial Grain Intermediate Wheatgrass (*Thinopyrum intermedium*) for Food Applications

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ABSTRACT

Intermediate wheatgrass (IWG) is a perennial grain with great potential to be developed as a grain crop. The environmental benefits of perennial crops in comparison to annuals include reduced soil and water erosion, reduced soil nitrate leaching, increased carbon sequestration, and reduced inputs of energy and pesticide. From a consumer perspective, the engagement in purchasing habits that can improve the environment is gaining prominence. The objective of this study was to evaluate chemical characteristics related to functionality and nutritive properties of IWG. IWG samples were screened for protein, fat, ash, starch, amylose to amylopectin ratios, and dietary fiber contents utilizing standard analytical procedures. Gluten-forming proteins (GFPs) were analyzed qualitatively by SDS-PAGE. Antioxidant activity of all samples was measured using Trolox equivalents. Lipase and lipoxygenase activities were assessed as indicators for rancidity. Statistical analysis of differences in enzyme activities and nutrient composition was performed through ANOVA. IWG samples were higher in protein, fat, ash, and dietary fiber, but lower in starch, than the wheat control. Starch contents showed some variation among IWG samples. However, amylose to amylopectin ratios were not significantly different among samples or to the wheat control. Lipase activities were significantly different among IWG varieties. Interestingly, IWG samples had higher antioxidant activity than the wheat control. GFP analysis indicated that IWG samples are mostly deficient in higher molecular weight glutenins, which negatively impacts dough formation. This work provided valuable feedback to the breeding program for the continued screening and breeding efforts to ultimately develop IWG with good yield, size and quality traits for food applications.

INTRODUCTION

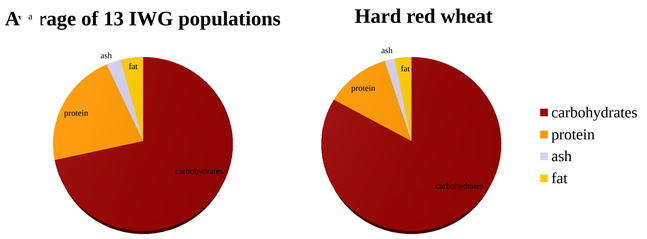
- In a screening study that evaluated agronomic characteristics of perennial grains, intermediate wheatgrass (*Thinopyrum intermedium*) was chosen as the most promising candidate for domestication efforts.
- Currently, IWG is only used for feed purposes. To expand IWGs application range to food products, it needs to be competitive to other grains in its performance. Our collaboration between plant breeders and food scientists focusses on evaluating IWG for food production.
- To ensure IWG's success in the market place, its baking performance needs to be known and should be as comparable to wheat as possible.
- Compositional factors that influence baking performance include starch and dietary fiber contents, as well as the amount and profile of gluten-forming proteins. For optimum dough development, a grain should contain high amounts of starch and gluten-forming proteins, especially glutenins, and low amounts of dietary fiber

MATERIALS AND

Parameter	Method
Protein content	Dumas
Prolamin profile	SDS-PAGE
Fat	Mojonnier
Carbohydrates	
Starch	Enzymatic assay
Amylose:Amylopectin Ratio	Enzymatic assay (ConA procedure)
Dietary Fiber	Total dietary fiber (AOAC 985.29)
Ash	Muffle Furnace combustion
Moisture	Vacuum-oven method
Lipase & Lipoxygenase	Rose & Pike 2006[2] & Li &Schwarz 2012[3]

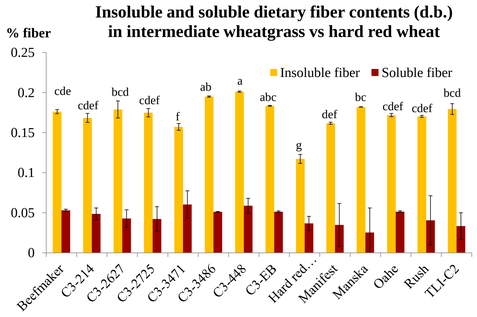
RESULTS

1. Proximate analysis

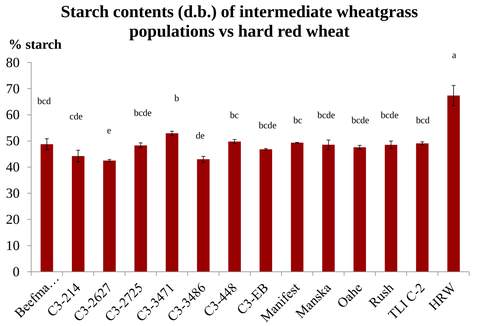


All breeding populations contained less carbohydrates, but more ash, lipids and protein

2. Carbohydrates

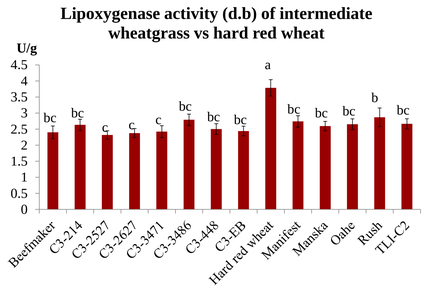


- IWG has significantly more total dietary fiber than wheat due to its high insoluble fiber content. In contrast, soluble fiber contents were not significantly different from wheat or among IWG populations

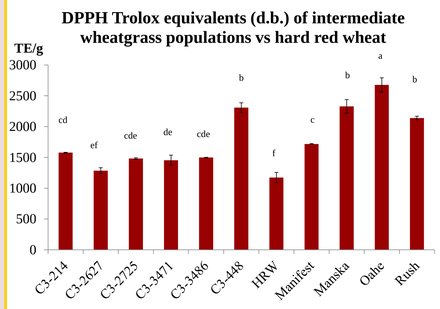


- This came at the expense of starch contents that were significantly lower than in wheat
- Both findings can be explained by the higher bran to endosperm ratio
- Amylose to amylopectin ratios were however comparable to wheat (data not shown), around 25:75. This value is common for cereal grains

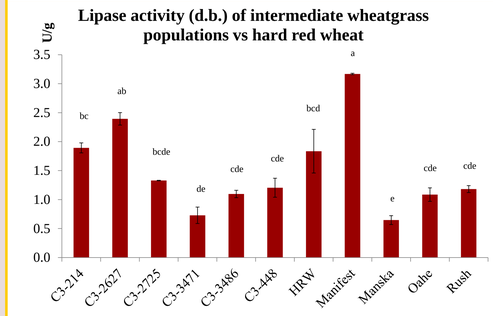
3. Enzyme activities & influencing factors



All IWG samples had lower lipoxygenase activity than wheat. In addition, we have observed higher antioxidant (AO) activity in IWG extracts than in wheat extracts. Multiple AOs commonly found in foods have been reported to inhibit lipoxygenase[4]. Further research is needed to confirm if IWG's endogenous AOs influence lipoxygenase activity

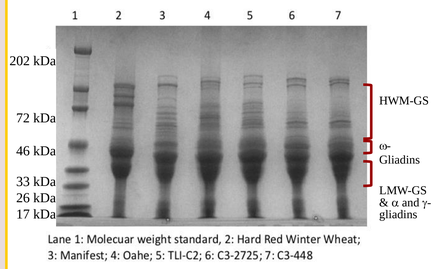


Grains contain solvent-extractable and cell-wall linked AOs. An evaluation of radical quenching activities of solvent-extractable AOs showed that all IWG populations contained higher values, likely due to higher bran contents.



Lipase activity varied significantly among samples, with IWG samples comprising both the highest and the lowest value. Low lipase activity could be used to select samples for future breeding studies

4. Gluten profile



Lane 1: Molecuar weight standard, 2: Hard Red Winter Wheat; 3: Manifest; 4: Oahe; 5: TLI-C2; 6: C3-2725; 7: C3-448

While containing more protein than wheat, IWG populations are deficient in gluten-forming proteins, particularly high-molecular weight glutenins (HMW), which provide doughs with elasticity. However, the samples did contain gliadins

Based on these results, IWG doughs can be expected to be extensible and viscous, but not very elastic. In addition, food products formulated with IWG could not be marketed as gluten-free.

SIGNIFICANCE & CONCLUSIONS

- Our results provide feedback for breeding efforts to ultimately develop IWG with good yield, seed size and quality traits for food applications
- High proteins, insoluble dietary fiber and ash contents make IWG a nutritious alternative to wheat
- For products where protein network formation is crucial, especially bread, IWG would best be combined with wheat flour or vital wheat gluten
- For batter recipes, additional starch and water may need to be added
- Breeding for lower lipase activity may be useful to ensure that rancidity development is at a minimum. More work is necessary to determine if AOs inhibit lipoxygenase activity
- Shelf life studies to evaluate stability over storage are warranted
- Identification of optimum bran content for acceptable quality and monitoring of dough strength upon addition dough conditioners is currently underway

ACKNOWLEDGEMENTS

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