FOR ADMINISTRATIVE USE
Minnesota Wheat Research and Promotion Council

Program Area Code **Proposal Code**

RESEARCH PROPOSAL GRANT APPLICATION

1. NAME AND ADDRESS OF ORGANIZATION TO WHICH AWARD SHOULD BE MADE
Name: North Dakota State University
Address: Office of Sponsored Programs Administration
NDSU Dept #4000; PO Box 6050
Fargo, ND 58108-6050

2. TITLE OF PROPOSAL
Exploring the Relationship between Glutenin Protein Compositions and Baking Absorption of HRS Wheat

3. PRINCIPAL INVESTIGATOR(S)
Dr. Minwei Xu

PI # 2 Name: Lingzhu Deng

PI # 3 Name:

4. PI #1 BUSINESS ADDRESS
North Dakota State University
Department of Plant Sciences
PO Box 6050, Dept 7670
Fargo, ND 58108-6050

5. PROPOSED PROJECT DATES (calendar years)
01/01/2023 to 12/31/2023
Note: Research Reports are Due November 15th of Each Year

6. TOTAL PROJECT COST
$36,720

7. PI #1 PHONE NO.
701-231-7737

8. RESEARCH OBJECTIVES: (List objectives to be accomplished by research grant)

1. This study will use proteomics and electrophoretic tools to evaluate the variability of glutenin protein compositions in HRS wheat.
2. This study will also evaluate the relationship between glutenin protein characteristics and baking absorption of HRS wheat.

Attach a 2-page detailed discussion of importance of the proposal to wheat profitability; how study complements previous research in area; procedures to be used; and competency of the research group in achieving research objectives. (Please keep the proposal concise, only 2 pages will be provided reviewers).

Signature of Principal Investigator
Minwei Xu

Date
1/5/23

Phone Number
701-231-7737

Signature of Authorized Representative
Dionna LQ Martel
Digitally signed by Dionna LQ Martel
Date: 2023.01.09 10:04:09 -06'00'

Title:
Proposal & Award Officer, Sponsored Programs Admin.

Date
1/9/2023

Address of Authorized Representative
Dept. 4000
PO Box 6050
Fargo, ND 58108-6050

Phone Number
701-231-8045

Minnesota Wheat Research and Promotion Council
RESEARCH PROJECT PROPOSAL
(2-pages maximum)

Abstract

Export demands for HRS wheat are particularly strong because the high quality of protein makes HRS wheat the best candidate, standalone or part of a wheat blend, for bread products. However, low water absorption of HRS wheat varieties has become a concern for Asia buyers and processors considering they reduce the yield of bread products. The low yield contributed to a reduced profit margin for the flour and baking business. Proteins as one of the main flour components that can affect water absorption (pentosans and damaged starch have no negative impacts on the water absorption of that flour according to overseas customers). This study will use proteomics and electrophoretic tools to evaluate the variability of glutenin protein compositions in HRS wheat and its relationship with baking absorption and breadmaking quality. This study will provide a direction, which is screening for certain glutenin protein compositions (or other components), for improvement of baking absorption of HRS wheat and increase the economic benefits of the high baking absorption of HRS wheat.

Describe the background for your proposed project and the importance of this project to the profitability of wheat production in MN

The water absorption of wheat flour is economically important because it affects the yield and quality of bread products. Higher water absorption will require an increased proportion of water (relative to flour) added to the formula to form the bread dough. For instance, 70% vs 65% baking absorption flour, in which the 5% higher baking absorption flour will require 25,000 extra grams of water to add into the flour for producing 1,000 loaves of bread when each loaf is a 500-gram flour base. More water added into flour means a higher profit margin for millers and bakers and they prefer to use the high baking absorption flour for bread products.

In the Crop Quality Surveys, the state average flour baking absorption of Minnesota HRS varieties was 64.3-67.9% from 2015 to 2022, 2.7- 4.5% down from Montana of 67.0-72.4%, and 1.5-3.6% down from North Dakota of 65.8-71.5%, respectively. The baking absorption of major HRS varieties grown in the North Plains also varies. Elgin ND, Faller, Glenn, Linkert, ND VitPro from 2015 to 2022 were similar for baking absorption, with an average baking absorption of 63.2-65.0%. For SY Ingmar, SY Valda, WB9479, and WB9590, the averages were 62.2-63.9% from 2015 to 2022. Shelly averaged 60.6% from 2015 to 2022 was the lowest baking absorption among the major HRS varieties.

Low water absorption of HRS wheat varieties has become a concern for Asia buyers and processors in the past few years. Especially from 2017 to 2018 when the major HRS varieties exhibited a low baking absorption of 59.3-63.3%. The Asia buyers and processors have blended other grains or high-water-absorption ingredients (i.e. Canada Western Red Spring wheat (baking absorption ~70%) or pea flour) into HRS wheat blends to improve their water absorption capacity. But they are not compromised on the baking absorption.

The low water absorption relates to the variation of the flour components. Starch is one of the major components in the flour, consisting of 65-70% of the flour on a dry matter basis. The damaged starch granule caused by the mechanical abrasion of rollers in the milling can absorb up to 3 times its weight in water when water is added to flour for mixing. Pentosan is approximately 1.5-2.5% of the flour and it absorbs up to 15 times its weight in water. Protein/gluten constitutes between 7% and 17% of the flour and can absorb approximately 2 times its weight in water. According to overseas customers, pentosans and damaged starch have no negative impacts on the water absorption of those flour. So the low water absorption related to the glutenin protein or other characteristics needs to be assessed.

The goal of this research is to investigate the glutenin protein compositions of HRS wheat cultivated in Minnesota. The relationship between glutenin protein characteristics and baking absorption will be evaluated. The research would provide a direction for improvement of baking absorption of HRS via screening for certain glutenin protein compositions and increase the economic benefits of high baking absorption of HRS wheat.

Research methods

Ten spring wheat varieties of low and high baking absorptions that were reported in previous years of the Crop Quality Surveys are selected. Their protein content, the number of glutenin fractions, subunits, thiol accessibility, and protein secondary structure will be assessed. The relationships between protein characteristics and baking absorption are assessed.

Potential HRS varieties to use in this study
Linkert
SY Valda
WB 9590
WB 9479
Bolles
Barlow
SY Ingmar
Shelly
Prevail
Glenn

Timeline for completion

January – February 2023	Collect samples
March – May 2023	Conduct wheat and flour protein extractions and quantitative analysis on Leco Nitrogen Analyzer, SDS – PAGE, and RP – HPLC
June – August 2023	Conduct thiol accessibility and protein secondary structure measurements
September – October 2023	Conduct NMR (if needed) and baking tests
November – December 2023	Data analysis and report writing

Outreach plan

1. Consult with the U.S Wheat Associates Beijing Office about the overseas customer's demands for high baking absorption of HRS wheat flour. Also, to seek support from them, e.g., get some blends information and/or get commercial blends sample. And try to set up ways to collaborate on this project.
2. Seek support from NDSU and UMN extensions for getting spring wheat varieties of low and high baking absorptions.
3. Talk and consult with NDSU plant science breeders to develop potential outreach activities.

List other current, pending, or planned funding sources and submissions for this project:
We are planning to use this study results as a base to apply more funding from USDA to conduct further work with breeders.

Research group (other collaborators not listed as PIs):
The research group is 1) Dr. Minwei Xu (PI), an Assistant Professor in the Cereal Science Graduate Program, Department of Plant Sciences at NDSU. He leads this project. And his lab is well-equipped for conducting protein quantitative analysis for cereal grains. Such as the SDS – PAGE, and RP – HPLC instruments.
2) Dr. Lingzhu Deng (co-PI), a Post - Doctoral Researcher in the Cereal Science Graduate Program, Department of Plant Sciences at NDSU. She has expertise in protein quantitative analysis and baking.
3) A new graduate student will perform experiments, collect and analyze data, and prepare manuscripts for publication under the PI's supervision.
4) Collaborator: The U.S Wheat Associate Beijing Office
The collaborator will provide commercial flour as reference samples and help to disseminate the research findings in their Crop Quality Seminars when international travel to China is open.

Relationship to past projects and research conducted by you or others in the region:

Tsilo, T. J., Nygard, G., Khan, K., Simsek, S., Hareland, G. A., Chao, S., and Anderson, J. A. (2013). Molecular genetic mapping of QTL associated with flour absorption and farinograph related traits in bread wheat. Euphytica. 194:293-302.

The past research conducted in the region is a good reference for this proposed research. They identified QTL controlling Farinograph water absorption in HRS and some QTL is localized at the chromosome regions of the low or high molecular weight glutenin genes. The flour water absorption coincides with flour protein content.

References

1. Spring wheat quality. Annual HRS Quality Report 2015 to 2022. https://www.ndwheat.com/research/wheatquality/springwheat/
2. Water absorption capacity of flour. KPM Articles & Insights. https://www.kpmanalytics.com/articles-insights/water-absorption-capacity-of-flour

Minnesota Wheat Research and Promotion Council

RESEARCH PROJECT PROPOSAL BUDGET

Project Title: Exploring the relationship between glutenin protein compositions and baking absorption of HRS wheat

Principal Investigator(s) / Project Director(s) Minwei Xu	Funds Requested For Year 1 (2023)	Year 2 (2024)	Year 3 (2025)
A. Salaries and Wages	$	$	$
1. Co-principal Investigator(s)			
2. Senior Associates			
3. Research Associates – Post Doctorate			
4. Other Professionals			
5. Graduate Students	24,000		
6. Prebaccalaureate Students			
7. Secretarial - Clerical			
8. Technical, Shop and Other			
B. Fringe Benefits	720		
C. Consulting and Professional Services			
D. Supplies and Services	10,500		
E. Travel	1,500		
F. Sub-Contracts			
G. Repairs & Maintenance			
H. Rentals & Lease			
I. Other Expenses			
TOTAL AMOUNT OF THIS REQUEST (per year)	**$36,720**	**$**	**$**

Budge Justification:

Total Direct Costs = $36,720

Salary + Fringe Benefits: ($24,720)
Graduate student – The graduate student will conduct experiments, collect and analyze data, and prepare manuscripts for publication. The experiments include the protein content, protein extractions, quantity of glutenin protein fractions and subunits of HRS wheat varieties via SDS-PAGE and RP-HPLC, thiol accessibility, NMR, and protein secondary structure. ($24,000)
The Fringe benefit at a rate of 3% is requested ($720)

Material & Supplies: ($10,500)
Purchase lab supplies for different experiments to fulfill this project.
SDS-PAGE supplies ($2,000): 1-propanol, Tris-HCl, SDS, glycerol, bromophenol blue, dithiothreitol, polyacrylamide gel, and protein standards, etc.
RP-HPLC supplies ($4,500): Agilent Zorbax Stablebond 300 C18 column, protein standards, nylon syringe filters, syringes, screw cap micro tubes, tube caps, HPLC grade water, HPLC grade acetonitrile, disodium hydrogen phosphate, potassium phosphate monobasic, 1-propanol, acetone, and 4-vinylpyridine.
Thiol accessibility supplies ($1000): SDS, glycine, EDTA, Tris-Hcl, DTNB solution, and glutathione.
Protein secondary structure and NMR experiment supplies ($2,500)
Baking test ($500) Sugar, shortening, salt, non-fat dry milk, yeast, baking pans, ascorbic acid, portable dough sheeter

Travel Expense: ($1,500)
Travel funds are to cover a graduate student or PI to the 2024 Cereals & Grains Association Annual Meeting in the U.S to present research results. The registration fee ($500), lodging cost ($500), airfare ($300) and meals ($200).