End-Use Quality of Wheat and Functional Properties of Whole Grain Wheat

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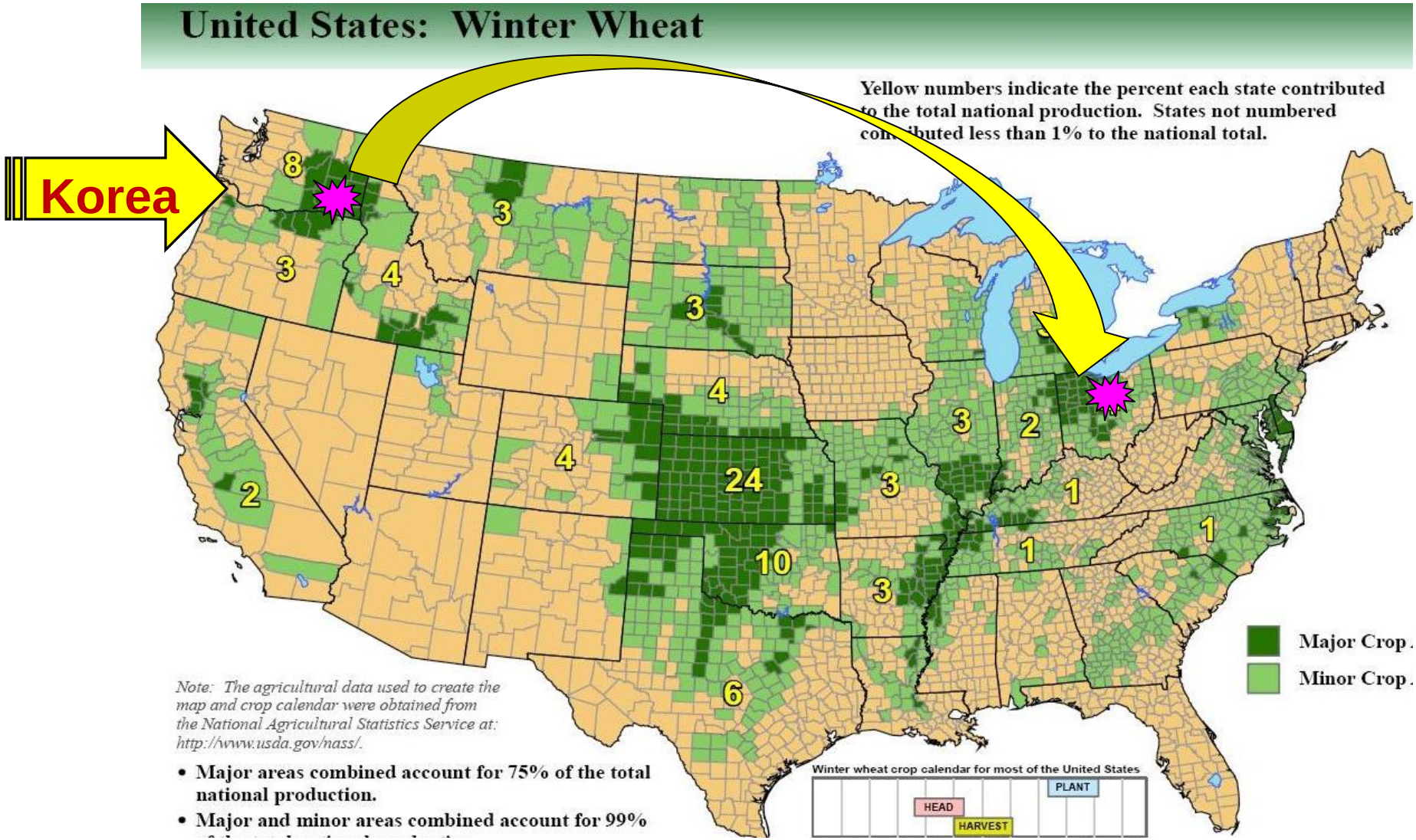
Soft Wheat Quality Laboratory

USDA-ARS



Source: USDA World Agricultural Outlook Board

End-Use Quality of Wheat for Asian Markets

Wheat Grown in PNW

- Production (~342 million Bushels)
  - ✓Soft white - 80%
  - ✓HW, HRW & HRS - 20%
- Markets
  - ✓Export - 85%
  - ✓Domestic - 15%

Major Uses of Wheat in Asian Countries

- White salted/alkaline noodles
- Instant fried noodles

Noodle Color vs. Polyphenol Oxidase (PPO)

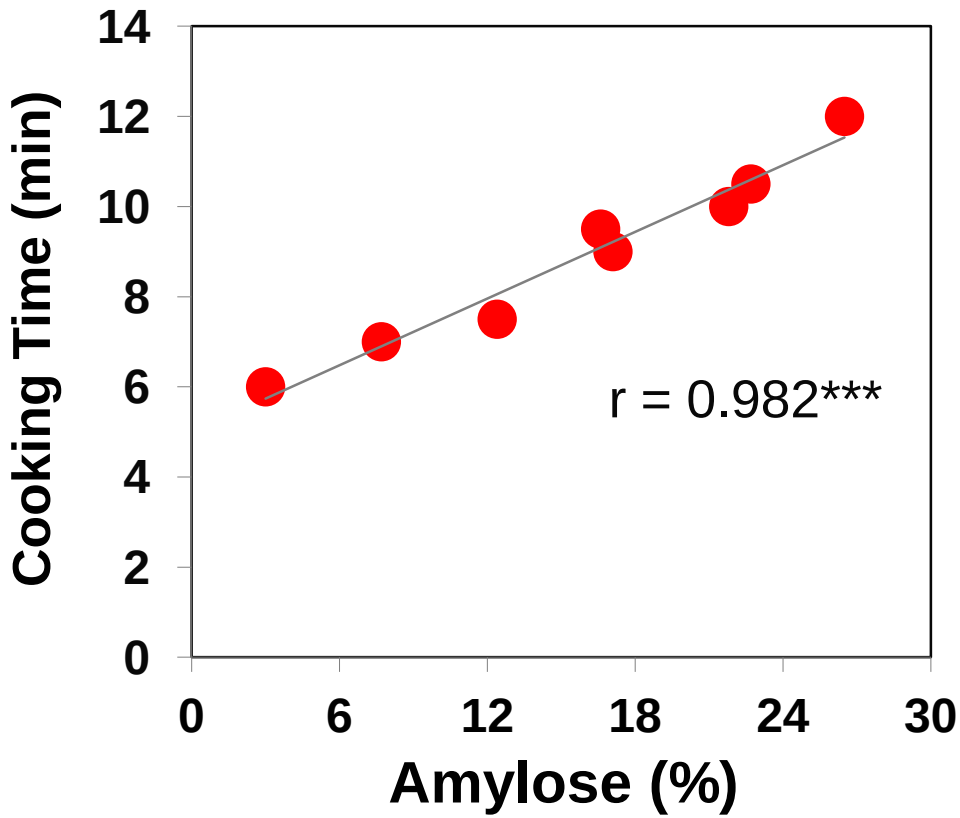
	Brightness of Noodles		
	Udon	Cantonese	Instant
PPO Activity	-0.82**	-0.83***	-0.88***

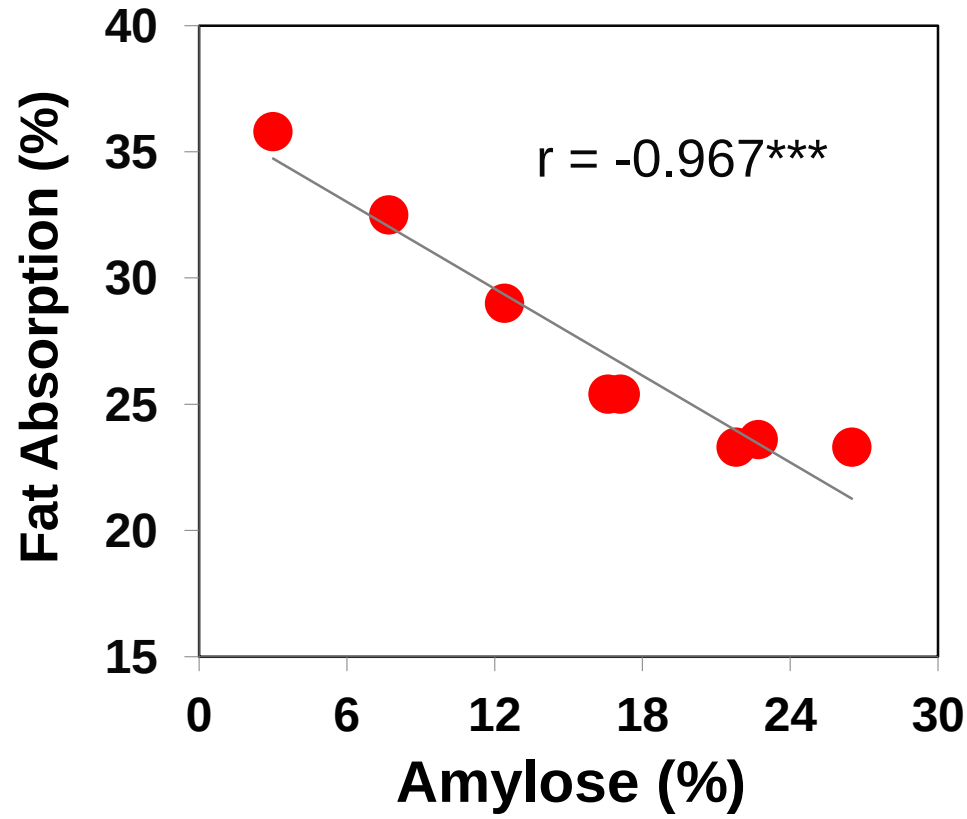
Influence of Starch Amylose Content on Texture of White Salted Noodles

Amylose (%)	Hardness (N)	Cohesiveness (ratio)
24.3	8.65	0.561
21.4	5.52	0.629
20.4	4.63	0.650
19.4	4.44	0.650

Cooking Time and Fat Absorption of Noodles

Amylose Content vs. Cooking Time and Fat Absorption of Instant Noodles





Protein Quality of Wheat Suitable for Making White Salted Noodles

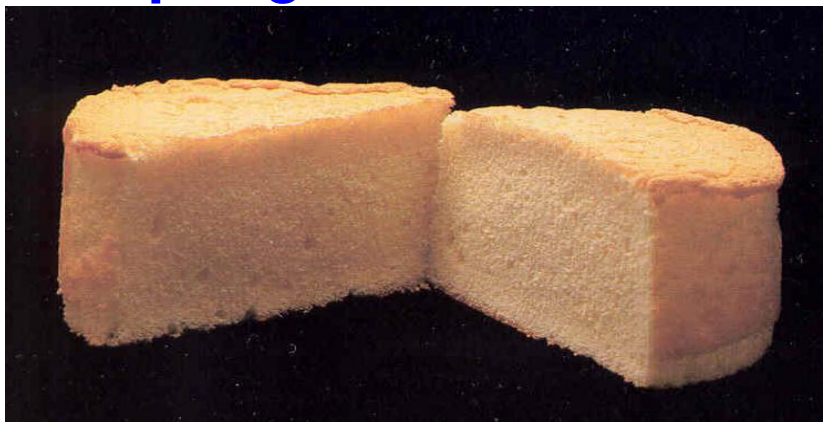
Wheat Flour	SDS Sed. Volume (ml)	Mixograph Mixing Time (sec)	Salt-Soluble Protein (%)	HMW-GS Score
Soft Wheat	22.0~44.5	48~95	15~19	4~8
Hard Wheat	31.5~46.0	145~330	11~16	9~10
Com. Noodle Flour	38.5~40.0	200~225	13~14	8~9

Baking Tests for Soft White & Club Wheat

Sugar-snap Cookie

- Simple, reliable & high throughput test for general soft white quality

Sponge Cake



- Standard end-use quality test of SW and club wheat for Asian markets

Conventional Sponge Cake Baking Test Procedure

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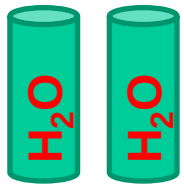
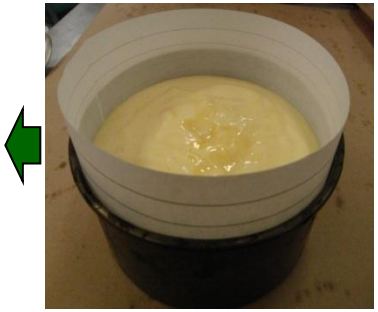




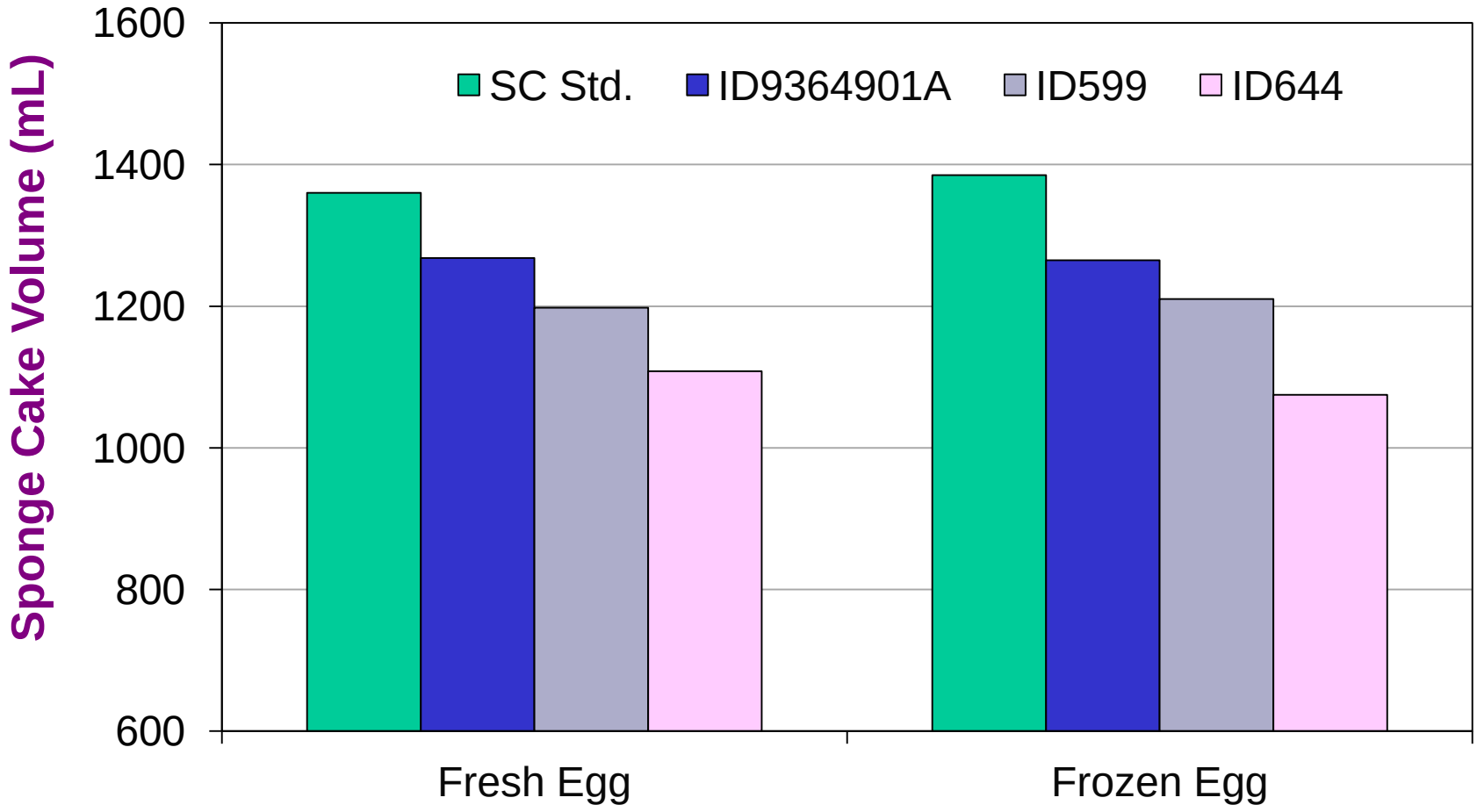
Modified Procedure of Sponge Cake Baking Test

Egg Whipping **Batter Mixing** **Panning & Baking**

Replacement of Fresh Eggs by Dry Powdered or Frozen Eggs

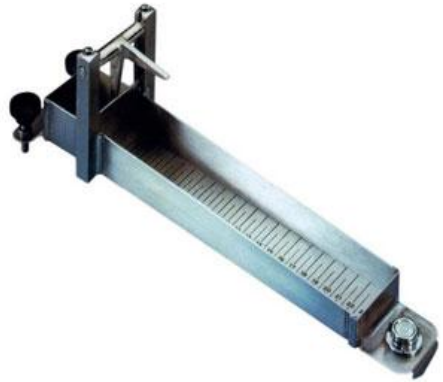
Egg Whipping **Batter Mixing** **Panning & Baking**

Use of Frozen Egg in Replacement of Fresh Eggs



Non-Baking Test: Batter Viscosity

- Flour-eggs-sugar-water (1:1:1:0.4)
- Flour-sugar-water (1:1:1)
- Flour-water (1:1.4)



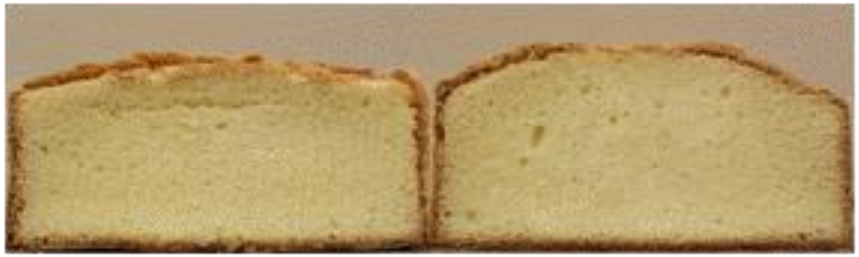
Bostwick
Flow Distance

Brookfield
Viscosity

Bostwick Flow Distance and Brookfield Viscosity of Batters vs. Sponge Cake Volume

Batter Type	Bostwick Flow Distance	Brookfield Viscosity
Flour-Eggs-Sugar-Water	0.734**	-0.723**
Flour-Sugar-Water	0.731**	-0.653*
Flour-Water	0.778**	-0.613*

SC of Wheat Flour
Before and After Re-grinding

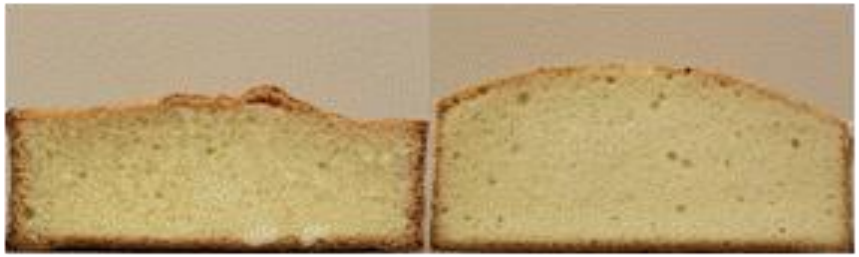


Before After

SC std flour

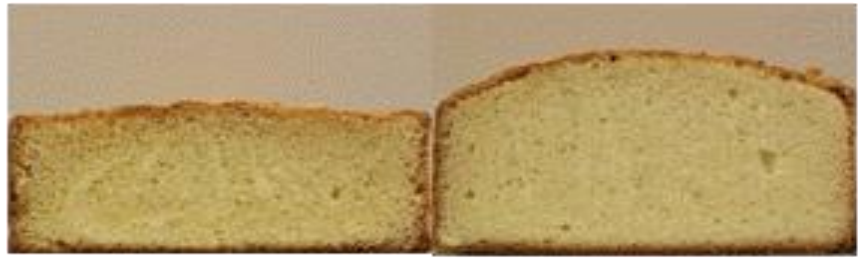
Before After

Eltan



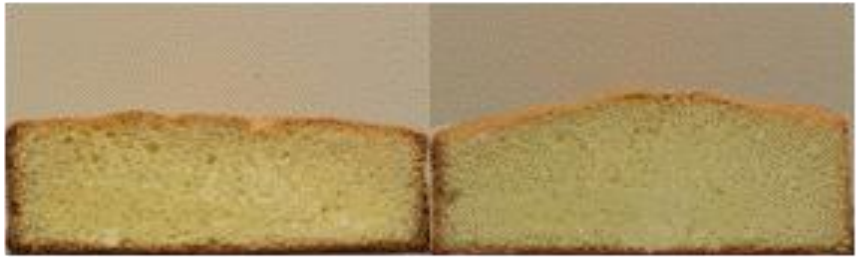
Before After

Orcf102



Before After

Cara



Before After

Darwin

Before After

Silver

SC of Flour Fractions of Different Particle Size

> 88 µm | 55-88 µm | < 55 µm

SC std flour

> 88 µm | 55-88 µm | < 55 µm

Eltan

> 88 µm | 55-88 µm | < 55 µm

Orcf102

> 88 µm | 55-88 µm | < 55 µm

Cara

> 88 µm | 55-88 µm | < 55 µm

Darwin

> 88 µm | 55-88 µm | < 55 µm

Silver

Correlations Between Characteristics of Wheat and Sponge Cake (SC) volume (N = 79)

Characteristics	SC Volume (mL)
SKCS Hardness	**-0.622*** **
Break Flour Yield (%)	**0.648*** **
Particles ≥63 μm (%)	**-0.737*** **
Protein (%)	-0.408***
SDSS Volume (mL)	-0.209
Carbonate SRC (%)	-0.214
Sucrose SRC (%)	-0.388***

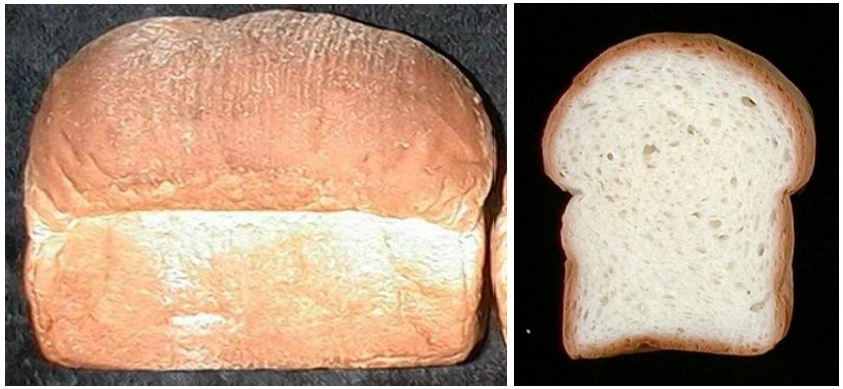
, * = significant at P<0.01 and P<0.001, respectively.

Whole Grains over Refined

- More fiber, minerals, vitamins, phytochemicals
- Low calorie density
- Low glycemic index

Sensory Quality and Acceptance of Whole Grain Wheat Foods

- Appearance: color, size, crumb structure
- Flavor & taste
- Mouth-feel & texture

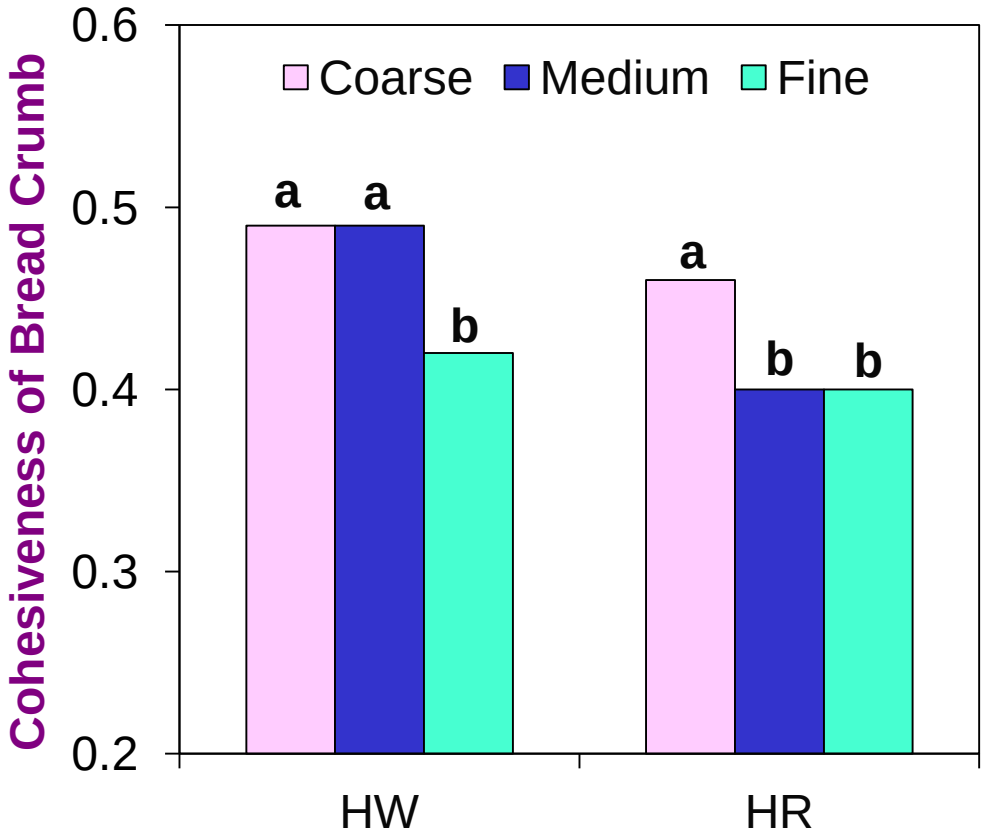


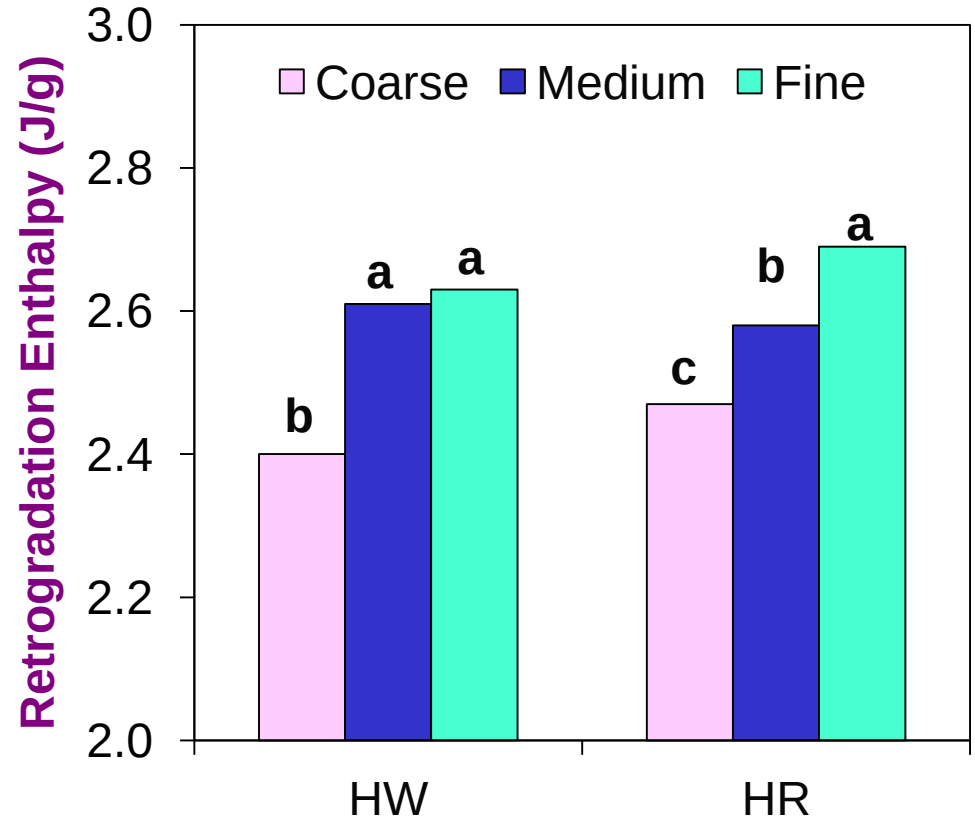
vs.

Whole Grain Wheat Research

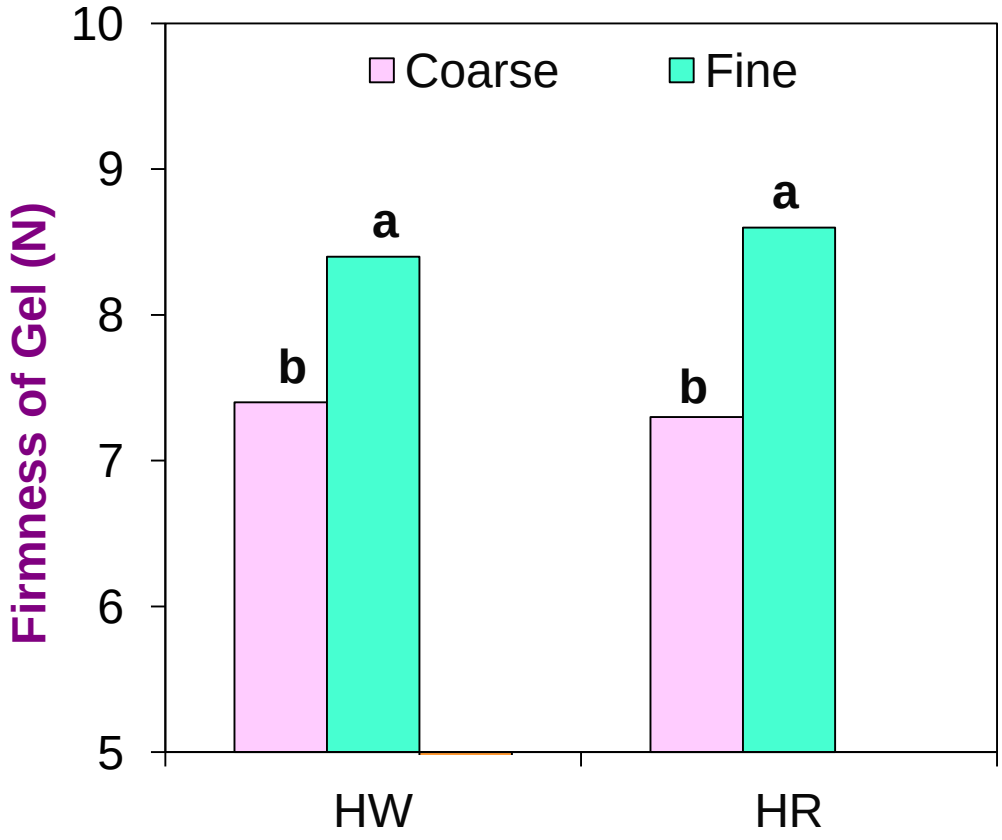
- Organic & no-till cropping systems on functional and nutritional quality of wheat
- Processing and product quality of whole grain wheat
  - Bran particle size reduction
  - Inherent bran characteristics
  - Role of grain phytates
  - Hydrothermal and enzymatic treatment of bran
  - Deep-oil frying on phenolic and antioxidant capacity

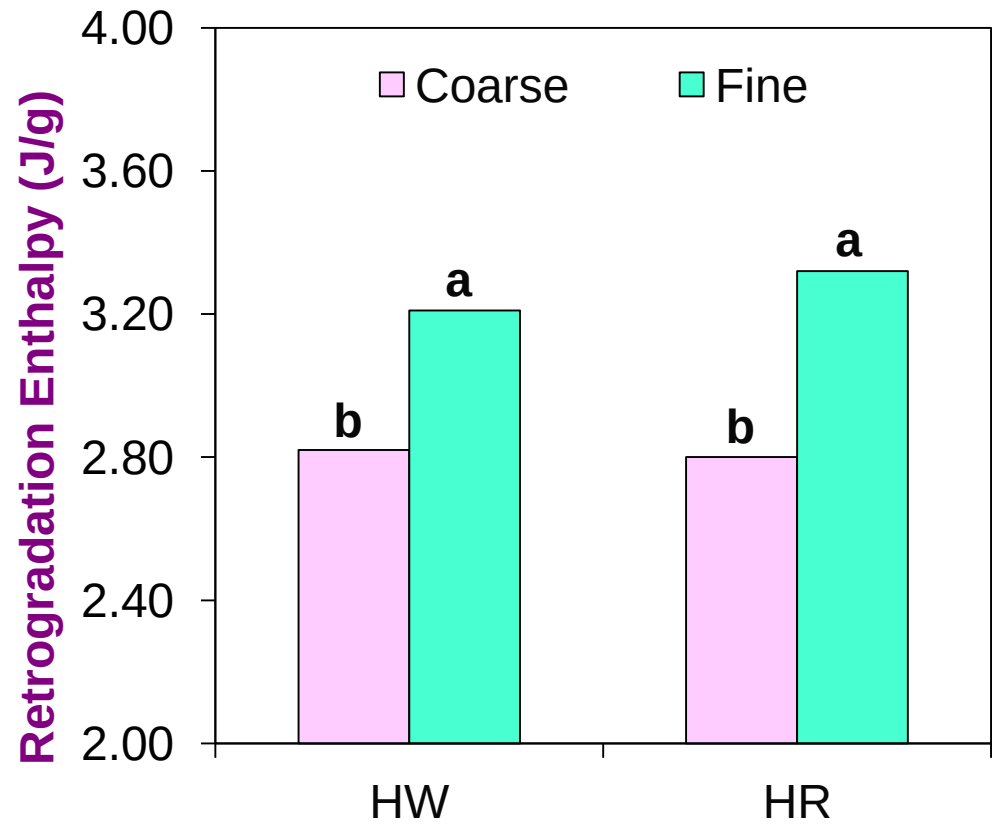
Bran Particle Size vs. Bread Crumb Texture & Starch Retrogradation





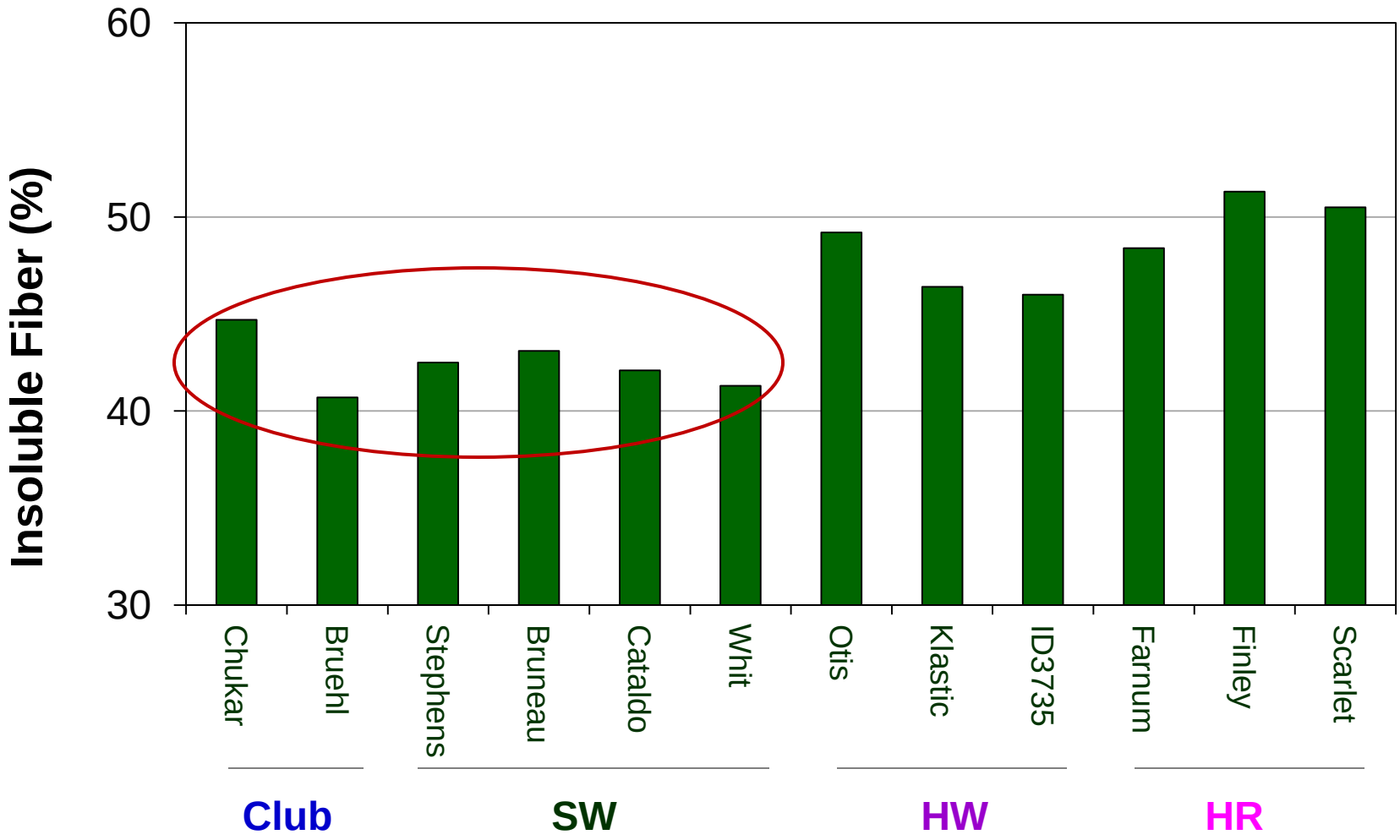
Bran Particle Size vs. Firmness and Retrogradation of Bran-Starch Gels



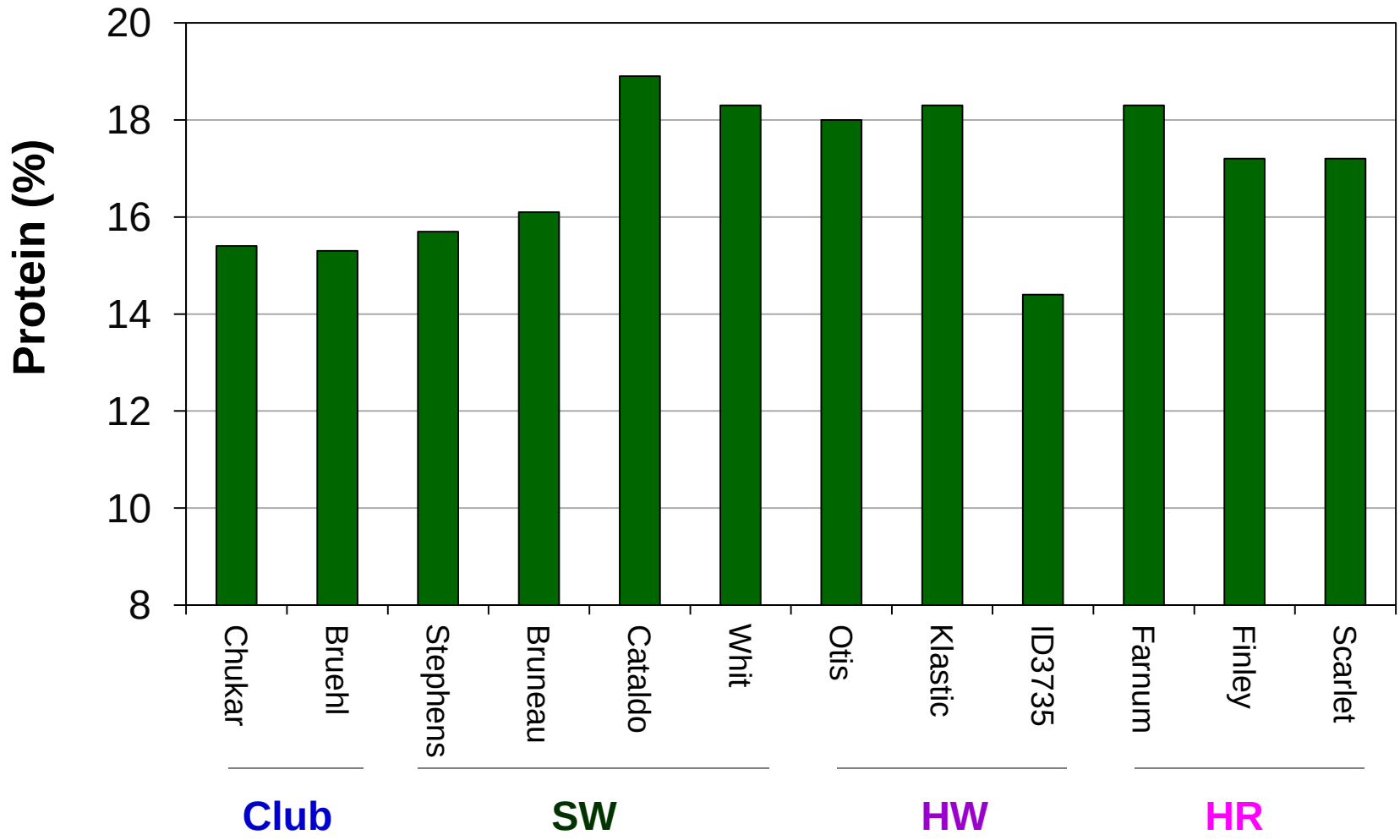


Bran Characteristics and Bread-Baking Quality of Whole Grain Wheat Flour

Insoluble Fiber Content of Bran



Protein Content of Bran



Fat, Ash and Soluble Fiber Content of Bran

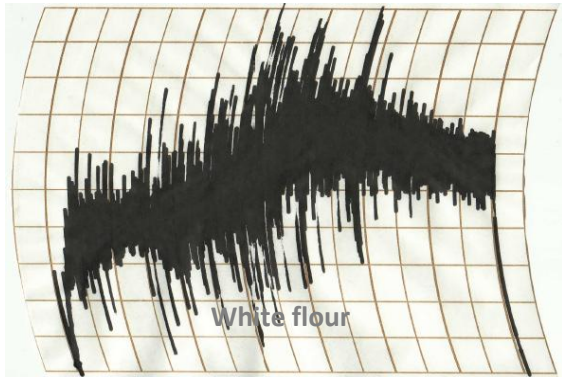
Class	Variety	Fat (%)	Ash (%)	SDF (%)
Club	Chukar	4.4	5.4	2.4
	Bruehl	4.8	4.6	3.7
SWW	Stephens	3.8	5.5	2.9
	Bruneau	4.4	6.8	4.0
	Cataldo	4.4	5.9	2.7
	Whit	4.5	6.6	3.5
HW	Otis	5.4	6.5	2.7
	Klastic	4.9	7.1	3.9
	ID3735	4.3	6.3	3.3
HR	Farnum	4.9	6.4	2.7
	Finley	3.8	8.2	4.2
	Scarlet	4.2	8.1	4.0

Mixograph Absorption and Mixing Time of Bran and HR Wheat Flour Blends

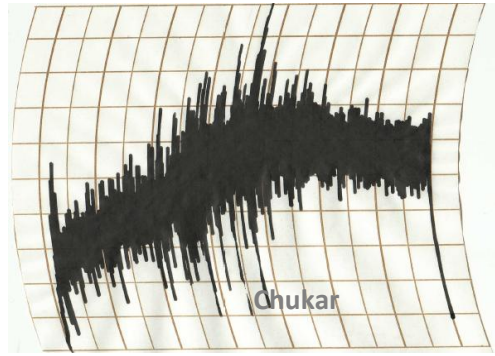
Class	Variety	Mixograph Absorption (%)	Mixing Time (min)
Club	Chukar	75	4.5
	Bruehl	74	4.0
SWW	Stephens	75	4.0
	Bruneau	74	4.0
	Cataldo	73	5.0
	Whit	74	4.0
HW	Otis	78	6.0
	Klastic	76	4.5
	ID3735	78	6.0
HR	Farnum	79	5.0
	Finley	77	5.0
	Scarlet	78	5.5

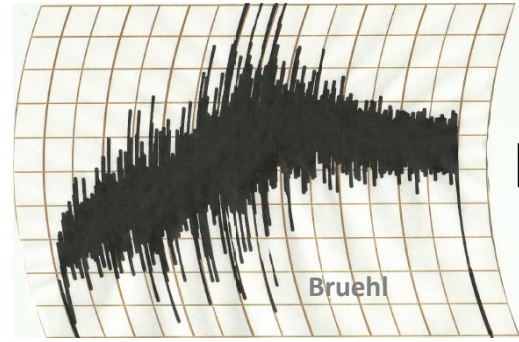
Mixograms of Wheat Flour & Bran and Wheat Flour Blends

Wheat Flour

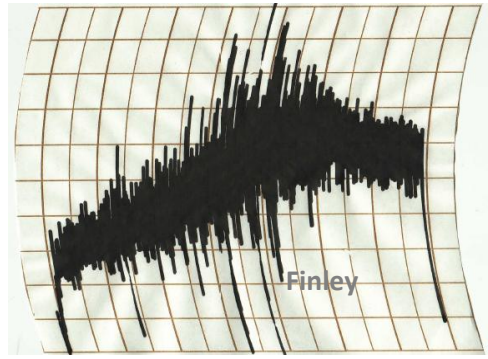


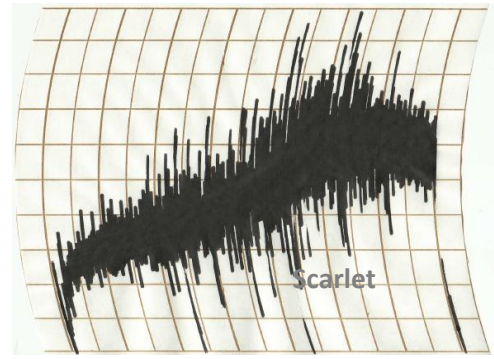
Bran + Wheat Flour





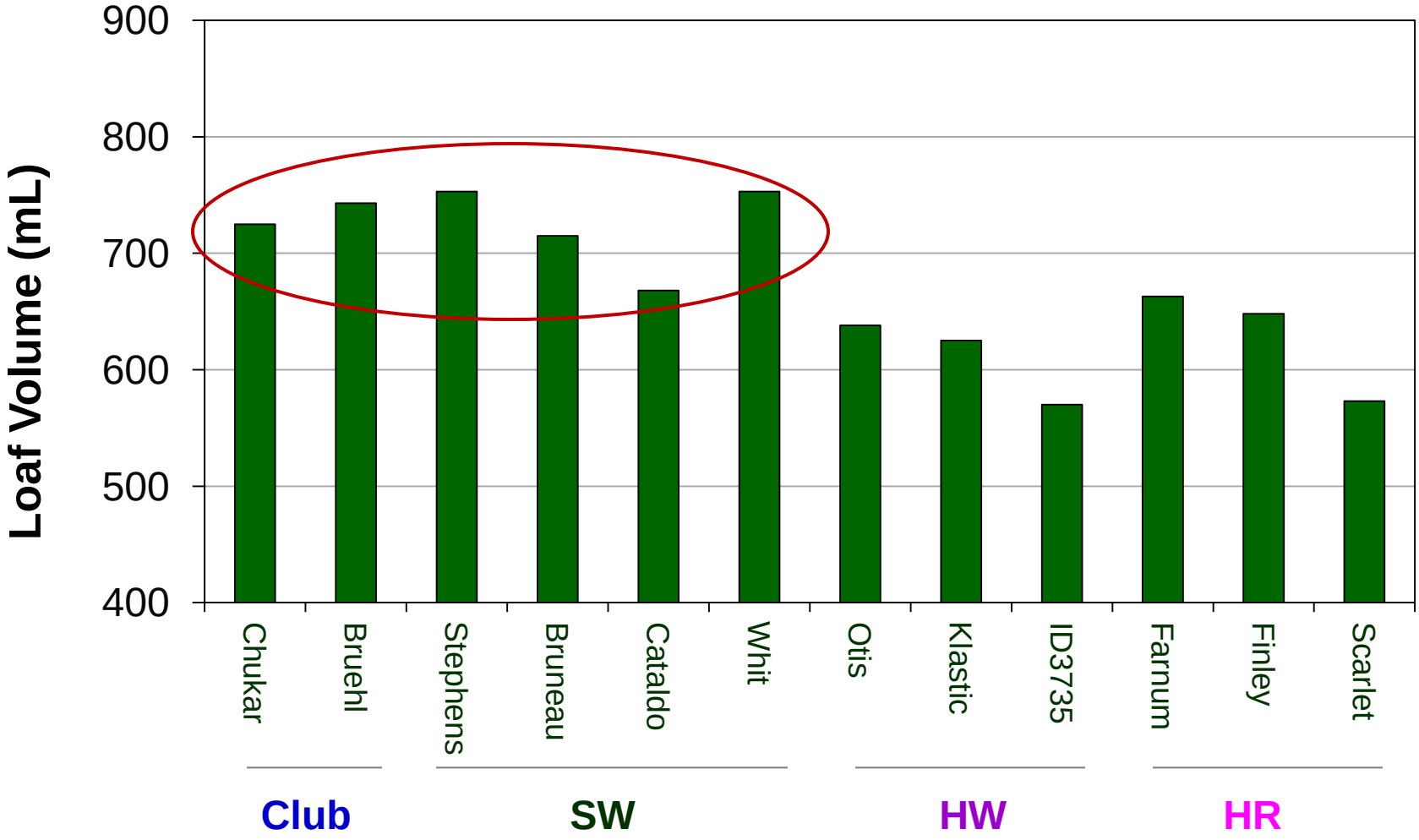
Low Fiber





High Fiber

Loaf Volume of Bread Baked From Bran and HR Wheat Flour Blends

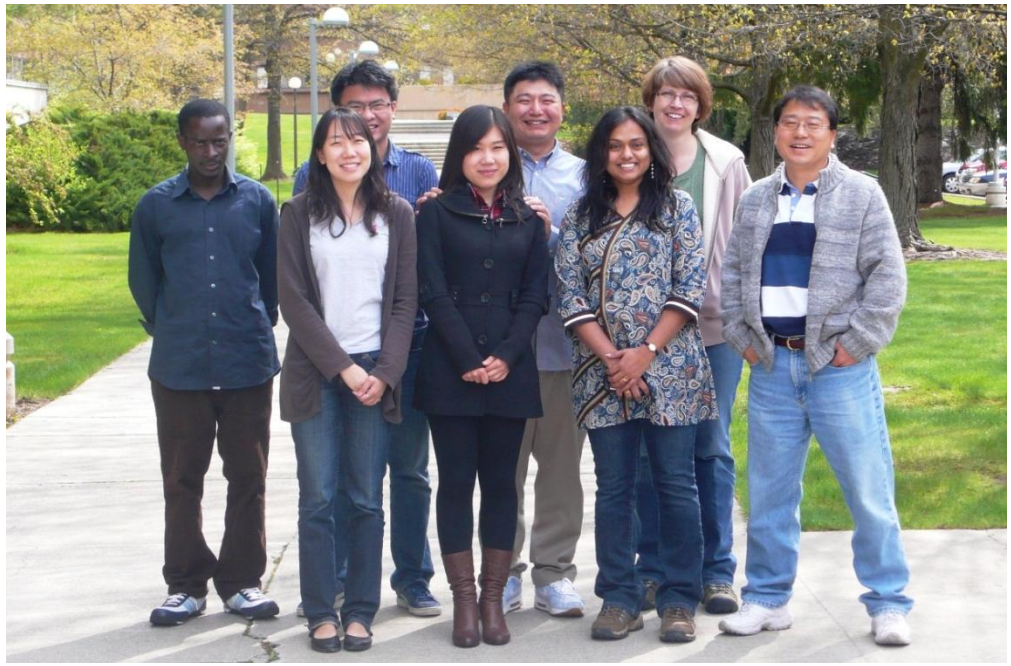


Bran Composition vs. Dough Properties & Loaf Volume of Bread

Bran Composition	Mixo. Absorption	Mixing Time	Loaf Volume
Protein (%)	0.03	0.09	-0.11
Fat (%)	0.19	0.22	-0.09
Ash (%)	0.47	0.37	-0.60
Insoluble Fiber (%)	0.85**	0.69**	-0.73**
Soluble Fiber (%)	-0.01	-0.18	-0.21

Acknowledgement

Cereal Biochemistry Program-WSU



Grant Funding

- Washington Grain Commission
- USDA-NIFA-OREI
- BioAg Program-WSU
- Shepherd's Grain
- RDA-NICS-Korea

USDA-ARS SWQL Staffs

Accomplishments of SWQL

- Performed quality analyses of breeding lines and varieties (>6,000)
- Performed quality analyses of regional and State performance nurseries
- Coordinated and participated in SWQC and OVA projects
- Conducted research on milling and baking test procedures, and genetic markers for quality traits

My Tasks at SWQL

- Effectively mange the lab to provide **accurate, reliable and timely** evaluation of end-use quality of wheat breeding lines and varieties
- Conduct research on **milling and baking quality traits** of soft wheat
- Meet the needs of soft wheat **growers**, **users and research collaborators**

Research at SWQL

- Efficient and reliable evaluation of wheat quality
  - Improvement of testing protocol/methods/interpretation
  - Adoption/development of cake and cracker baking tests
- Whole grain wheat: functional & nutritional quality
- Genetic markers for end-use quality traits
  - Flour milling quality
  - Baking quality traits
- Expanded uses of soft red wheat
  - Suitability of SRW wheat for non-conventional SRW wheat foods
  - Identification of quality traits important for those foods

Works in Action

- Comparative Miag milling of soft wheat between SWQL and WWQL
- Influence of lag time between milling and flour testing on quality parameters
- DNA markers for end-use quality