Evaluation of Wheat Protein Isolate in Sponge and Dough White Pan Bread

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INTRODUCTION

MGP Ingredients, Inc., Atchison, Kansas sponsored a research project with the American Institute of Baking (AIB) to evaluate the performance of two (2) wheat protein isolates, Arise™ 5000 and Arise™ 6000, in sponge and dough white pan bread. The project commenced on September 2000 and the results of the study is reported below.

OBJECTIVE

The objective of this project was to study the effect on mixing time, loaf quality and shelf life of wheat protein isolate in white pan bread.

MATERIALS AND METHODS

MGP Ingredients, Inc. supplied the test ingredients to AIB. Two wheat protein isolates (WPI) were evaluated. All other ingredients included those commonly used in the commercial production of white pan bread and were supplied by AIB. Farinographs were run with the bread flour used for the best baking and also with 1.0, 1.5 and 2.0% of each WPI added.

Sponge and Dough White Pan Bread:

Sponge and dough white pan bread was produced according to the formula and procedures included in Table I. Two WPI's were evaluated separately. WPI Arise™ 5000 and Arise™ 6000 were each added at 1.0, 1.5 and 2.0% (f.b.) to the dough side of the formulation. These test variables were compared to control breads with no added test ingredient.

Each of the variables and the control were optimized for water absorption and mixing time. The farinograms and subjective monitoring of gluten development on test doughs determined ranges for water absorption and mixing times. Water absorption was optimized for each of the test variables through a series of test bakes. Water absorption was increased by increments of 2% (f.b.) during each test dough series. Three different water absorptions were run on each test variable. Three mixing times were tested at each absorption to optimum dough development. Dough characteristics were subjectively evaluated and breads formed and baked. Breads were subjectively evaluated one day after baking. An optimum water absorption level was determined from the data on dough and finished product characteristics.

All doughs were produced under controlled conditions in duplicate. Doughs were subjectively evaluated for handling characteristics during mixing and at make-up.

Loaves were proofed to volume in pans prior to baking. Weight and volume of the baked bread was measured one hour after baking. Loaves were then double wrapped in polyethylene bread bags for storage. Baked breads were subjectively evaluated for external, internal and eating quality characteristics one day after baking.

Firmness of the bread crumb and crumb firming rate were measured on 1, 4, 7 and 11 days after production using the Texture Technologies TA:XT2 Texture Analyzer. Significance of the differences in crumb firmness values was evaluated using analysis of variance and linear contrasts. Internal crumb structure of the breads was objectively measured using CrumbScan™, a computer generated software package developed at AIB that measures crumb fineness and cell shape.

RESULTS

Water absorption and mixing times were optimized for each of the variables. Farinograms were run with the addition of the Arise™ 5000 and Arise™ 6000 at the levels evaluated in the bread doughs. Results indicated that as the ingredients were added, and the level of addition increased, water absorption increased (Table II). Farinogram stability decreased and Mixing Tolerance Index (MTI) increased with the addition of either of the test ingredients. This is indicative of some type of reducing action on the dough structure.

Water absorption in the bread doughs was evaluated over a range of 59.0 to 64.5% and mixing times were varied from 4 to 8 minutes. Generally, as either of the test ingredients was added to the dough an increase in absorption and a decrease in mixing time could be achieved to maintain dough characteristics similar to the control. Subjective evaluation of dough characteristics determined the following protocol for the ingredient testing:

- Control doughs were mixed 6 minutes with 60% water absorption.
- Doughs with 1.0% Arise™ 5000 were mixed 5 minutes with 60% water absorption.
- Doughs with 1.5% Arise™ 5000 were mixed 4.5 minutes with 61% water absorption.
- Doughs with 2.0% Arise™ 5000 were mixed 4 minutes with 62% water absorption.
- Doughs with 1.0% Arise™ 6000 were mixed 5 minutes with 60% water absorption.
- Doughs with 1.5% Arise™ 6000 were mixed 4.5 minutes with 61% water absorption.
- Doughs with 2.0% Arise™ 6000 were mixed 4 minutes with 62% water absorption.

Doughs containing Arise™ 5000 or Arise™ 6000 were characterized as slack or sticky out of the mixer compared to the control dough. However, at make-up the characteristics of the test doughs had recovered and were rated slightly higher compared to the control doughs (Table III).

The addition of Arise™ 5000 and Arise™ 6000 did not seem to affect the proofing time of the dough. Some variables took slightly longer and some slightly shorter time as compared to the control. Averaging the proof times of the replicate runs did not indicate any notable difference. Control dough proof time ranged from 65 to 68 minutes. Doughs containing Arise™ 5000 had proof times ranging from 67 to 71 minutes. Doughs containing Arise™ 6000 had proof times ranging from 66 to 68 minutes.

Loaf volume increased when either of the test ingredients was added at any levels as compared to the control (Figure 1). A statistically significant increase in loaf volume was noted with the addition of 1.5% and 2% Arise™ 5000. With respect to Arise™ 6000, all levels of addition resulted in a significant increase in loaf volume. The loaf volume potential of bread with 1.5% Arise™ 5000 is equal to that with 1% Arise™ 6000.

Total quality scores were slightly higher when either of the test ingredients were added. The control breads had an average score of 81.63 compared to the highest total score of 83.25 for the breads made with 2% Arise™ 5000 (Table III and Figure 2). Test breads generally scored better than the control because of higher scores for symmetry, and break and shred.

Internal structure (grain) of the breads was evaluated using CrumbScan™. Fineness scores are reported in Table IV and Figure 3. Higher scores indicate a finer grain. However, it is generally considered that readings with a difference of less than 50 points are not significantly different. All scores ranged between 913 and 940 points and would therefore not be considered different (Table IV).

Crumb firmness was measured on days 1, 4, 7, and 11 after baking. Values are reported in Table V and Figure 4. All breads increased in crumb firmness over the evaluation period. Differences between the sample readings were not significantly different when analyzed using analysis of variance (Table VI).

CONCLUSIONS

1. The addition of Arise™ 5000 or Arise™ 6000 increases dough water absorption, and the absorption increases as the level of addition increases from 1.0 to 2.0%.
2. The addition of Arise™ 5000 and Arise™ 6000 decreases dough mixing time, and the mixing time decreases as the level of addition increases from 1.0 to 2.0%.
3. The addition of Arise™ 5000 and Arise™ 6000 causes a slackening effect on the dough out of the mixer, however, dough characteristics recover to optimum at the makeup stage.
4. The addition of 1.5% and 2% Arise™ 5000 or 1%, 1.5%, and 2% Arise™ 6000 causes a significant increase in loaf volume, but does not affect the internal structure (grain) of the baked bread. A 1.5% level of Arise™ 5000 has a similar performance in enhancing loaf volume of bread as 1% level of Arise™ 6000.
5. The addition of Arise™ 5000 or Arise™ 6000 does not significantly affect the shelf life characteristics of white pan bread, as measured by crumb firmness.

Table I. Sponge and Dough White Pan Bread

Ingredients	Baker's %	Total %
SPONGE		
Flour, bread	70.0	22.8
Yeast (compressed)	2.0	0.13
Yeast food (non-bromated)	0.5	0.03
Water	42.0	26.3
DOUGH		
Flour, bread	30.0	18.7
High fructose corn syrup (42%)	10.0	6.3
Soybean Oil	2.0	1.3
Salt	2.0	1.3
Calcium propionate	0.12	0.075
Water	Variable	Variable

Procedure

Mixer: Hobart A-120 mixer with McDuffee bowl and fork agitator.

Sponge: Mix the sponge ingredients for 1 minute at speed one. Mix again for 1 minute at speed two. Desired temperature of the sponge after mixing is $79^0F \pm 1^0F$.

Fermentation: Allow the sponge to ferment for 4 hours at 84^0F in a covered container.

Dough: Place the dough ingredients in the mixing bowl and mix for 30 seconds at speed one. Add the sponge and mix for 30 seconds on speed one. Mix the dough at speed two to optimum gluten development. Desired dough temperature is $79^0F \pm 1^0F$.

Floor Time: Allow the fully mixed dough to rest for 20 minutes at 84^0F in a covered container.

Scaling Weight: 18.5 oz. per loaf (2 loaves per batch).
Intermed. Proof: Divided dough (524 grams) should be allowed to rest for 10 minutes at room temperature.
Molder: Straight grain.
Proofing: Place the molded loaves into bread pans and place in proofing cabinet at 110^{0}F, 81.5% relative humidity. Allow the dough to rise to 5/8" above the top of the pan.
Bake: 22 minutes at 420^{0}F.

Table II. Farinogram Data

Variable	Absorption %	Peak Time Min.	Stability Min.	MTI, BU
Control	61.0	6.5	14.75	30
1.0% A-5000	63.0	5.5	10.00	40
1.5% A-5000	64.0	5.0	8.50	50
2.0% A-5000	65.0	5.5	6.75	55
1.0% A-6000	63.0	5.5	10.00	35
1.5% A-6000	64.0	6.5	7.75	50
2.0% A-6000	64.5	6.0	7.25	60

Table III. Subjectively Evaluated Characteristics of White Pan Bread (Large Batch Production, Average of Duplicates)

Variable	Dough	Bread		Total Quality Score
		External	Internal	
Control	23.25	14.88	43.50	81.63
1.0% Arise™ 5000	23.25	15.13	44.00	82.38
1.5% Arise™ 5000	22.75	15.63	44.50	82.88
2.0% Arise™ 5000	22.75	15.50	45.00	83.25
1.0% Arise™ 6000	22.75	15.50	44.75	83.00
1.5% Arise™ 6000	22.75	15.38	44.00	82.13
2.0% Arise™ 6000	22.25	15.63	44.00	81.88

Table IV. Objectively Measured Characteristics of White Pan Bread (Large Batch Production, Average of Duplicates)

Variable	Volume cc	Specific Volume, cc/g	CrumbScan™ Fineness
Control	2473	5.28	929
1.0% Arise™ 5000	2484	5.31	934
1.5% Arise™ 5000	2578	5.54	933
2.0% Arise™ 5000	2542	5.45	913
1.0% Arise™ 6000	2607	5.60	930
1.5% Arise™ 6000	2573	5.54	916
2.0% Arise™ 6000	2591	5.56	940

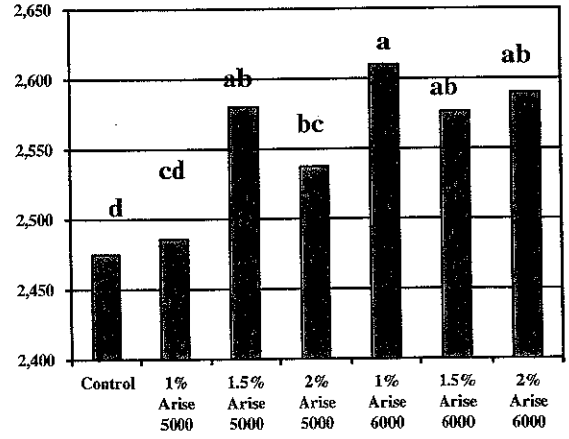
Table V. Crumb Firmness Values of White Pan Bread

Variable	Day 1		Day 4		Day 7		Day 11	
	Avg	SD	Avg	SD	Avg	SD	Avg	SD
Control	104	6.0	176	11.9	228	8.5	299	18.3
1.0% A-5000	109	4.2	162	18.1	246	34.4	301	14.8
1.5% A-5000	97	6.0	176	8.6	243	11.9	296	19.1
2.0% A-5000	99	7.9	158	10.2	225	19.1	273	10.1
1.0% A-6000	97	6.3	161	9.4	243	18.9	298	8.2
1.5% A-6000	102	7.0	170	8.7	234	23.2	297	24.5
2.0% A-6000	102	8.2	180	10.0	246	16.0	287	16.9
Control	123	4.2	193	10.8	257	15.5	313	30.2
1.0% A-5000	108	7.4	164	---	233	19.0	306	35.0
1.5% A-5000	103	6.5	172	9.4	229	12.8	276	20.6
2.0% A-5000	97	4.6	179	5.8	238	17.2	290	13.1
1.0% A-6000	107	7.5	183	8.6	244	18.3	297	12.4
1.5% A-6000	100	7.5	175	19.3	222	8.3	283	13.3
2.0% A-6000	93	5.7	182	16.1	223	17.8	308	26.8

Table VI. Statistical Analysis of Crumb Firmness Values of White Pan Bread

Variable	Mean Square	F Value	PR > F
Day	95131.82	1489.59	0.0001
Control vs. Arise™ 5000	930.22	4.61	0.0689
Control vs. Arise™ 6000	632.51	3.14	0.1199
Arise™ 5000 vs Arise™ 6000	57.23	0.28	0.6107

Figure 1 - Loaf Volume



Different letters means significant difference

Figure 2
Subjective Total Quality Score Values
Of White Pan Bread

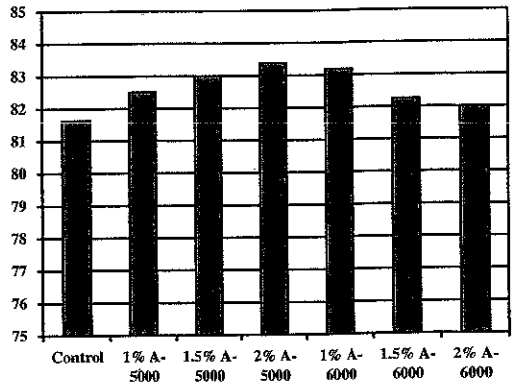


Figure 3
CrumbScan™ Fineness Values of White Pan Bread

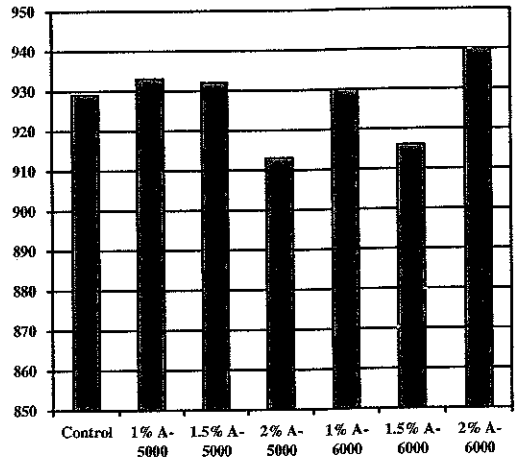


Figure 4
Crumb Firmness of White Pan Bread