



U.S. Wheat Associates

**Research Report Addendum
November 2022**

Title: Development of a mechanized folding method for sponge cake production and its comparison to the traditional hand folding method

Introduction

Wheat Marketing Center (WMC) recently completed a study focused on the development of a mechanized folding method for Japanese sponge cake production as an alternative to the traditional hand folding method (Nagao et al., 1976). In addition to addressing the challenges of adapting and further developing the original mechanized folding method developed by Choi, Harris and Baik (2012) and currently utilized by the USDA Western Wheat Quality Laboratory (WWQL), WMC compared the two folding methods using two control flours: a commercial Japanese short patent flour and an experimentally milled soft white wheat flour.

The initial results showed that cake volumes decreased when moving from hand to mechanical folding regardless of flour type. The decrease was ~50 cc when moving from hand to mechanical folding at sea level but may be more significant at higher elevations. Cake firmness also significantly increased as volume decreased. This increase in firmness resulted in greater points loss for mechanically folded cakes from experimental flours despite being compared against a mechanically folded Japanese short patent control.

The limitation of this study is that only two flours were compared across both methods. The data set was too small to draw meaningful conclusions regarding how the two folding methods correlate. To this end, WMC collected all 2022 harvest composites from the USW Crop Quality (CQ) and Pacific Northwest (PNW) Soft White Wheat (SWH) reports and compared cakes made with both the hand and mechanized folding methods. The following results are presented as an addendum to the initial report to expand on the conclusions and provide guidance regarding additional method development activities.

References

- Choi HW, T Harris and BK Baik. 2012. Improvement of sponge cake baking test procedure for simple and reliable estimation of soft white wheat quality. *Cereal Chem* 89:73-78.
- Nagao S, S Imai, T Sato, Y Kaneko and H Otsubo. 1976. Quality characteristics of soft wheats and their use in Japan. I. Methods of assessing wheat quality for Japanese products. *Cereal Chem* 53:988-997.

Results

(Supplementary results in Appendix B)

WMC generated two sets of composite samples for the 2022 soft white wheat harvest. Those composite sets included:

- 3 soft white wheat composites for the USW CQ report (3 protein categories)
 - Wheat protein categories
 - Low protein (< 9.0%)
 - Medium protein (9.0 – 10.5%)
 - High protein (> 10.5%)
- 18 soft white wheat composites for the PNW SWH report (5 production zones; up to 5 protein categories per production zone)
 - Production zones
 - North Central
 - Northeast
 - Central
 - Southeast
 - Southwest
 - Wheat protein categories
 - < 8.5%
 - 8.5 – 9.4%
 - 9.5 – 10.4%
 - 10.5 – 12.0%
 - > 12.0%
- 1 overall white club composite

Japanese sponge cakes were baked with each composite using the hand folding method as part of the overall CQ process. WMC repeated the Japanese sponge cake baking process with the mechanized folding method within 2 weeks of the initial hand fold bake.

Volume rankings were compared across both methods as an initial indicator of method alignment (Table 1). Rankings were used in lieu of directly comparing cake volumes given the noted volume differences in the initial report. General consistency in the ranking of cakes from low to high volume would be an indicator that the methods are aligned. As shown in Table 1, the five samples giving the lowest volumes with the hand folding method were highlighted in red and those five samples giving the greatest volumes highlighted in green. It is assumed in ranking comparisons that the worst and best performing samples will be clearly separated, while those samples with intermediate performance may show some small deviations. The mechanized folding method, as currently performed, failed to clearly separate the best and worst performing composites on a volume basis in a manner consistent with the hand folding method.

Table 1. Volumes and volume rankings for Japanese sponge cakes baked from 2022 soft white wheat harvest composites using either the hand or mechanized folding methods.

	2022 CQ SWH Sample #	Hand Fold Volume (cc)	2022 CQ SWH Sample #	Mechanized Volume (cc)
Low Volume	0995	1034	0988	996
↓	0983	1045	0992	1006
	0991	1080	0996	1014
	0994	1081	0994	1016
	0982	1093	0990	1020
	0990	1096	120221005	1040
	120221006	1101	0983	1047
	0989	1115	0991	1050
	0993	1116	0980	1053
	0996	1118	0979	1054
	0986	1121	0995	1054
	0981	1124	0984	1068
	0987	1126	120221004	1074
	120221005	1131	0985	1079
	0980	1136	0989	1080
	0985	1145	0982	1081
	120221007	1150	120221006	1083
	120221004	1157	0993	1091
	0979	1163	0987	1099
	0988	1176	0986	1104
	0984	1181	0981	1117
High Volume	0992	1194	120221007	1123

In addition to ranking assignments, the relationship between protein content and cake volume was assessed for both sponge cake folding methods. While protein content is not indicative of quality outcomes, it is generally expected that Japanese sponge cake volumes will decrease as composite protein content increases. This correlation generally holds for soft white wheat under normal growing conditions. Hand folded cakes showed the expected negative correlation with composite protein content (Figure 1). Mechanically folded cakes did not show a strong relationship with protein content. This discrepancy is aligned with the lack of agreement between the folding methods for Japanese sponge cake volume rankings.

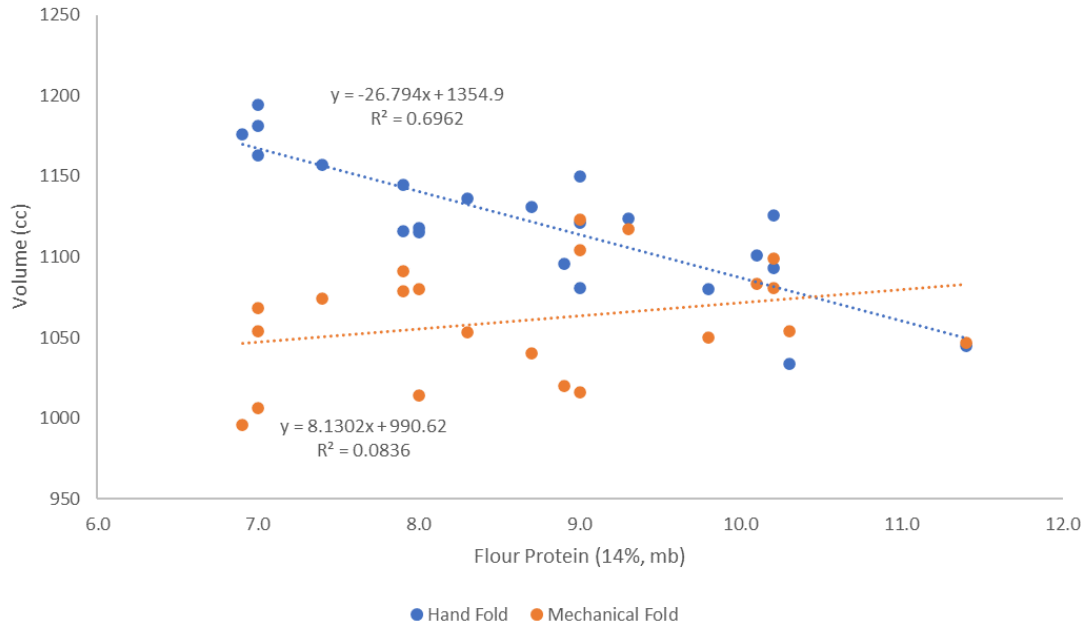


Figure 1. Relationship between protein content and volumes for Japanese sponge cakes baked from 2022 soft white wheat harvest composites using either the hand or mechanized folding methods.

Conclusions

The lack of agreement between Japanese sponge cakes produced the hand and mechanized folding methods indicates that the mechanized folding method requires further refinement. This is a normal occurrence during new method development, especially when the new method must be aligned with an existing method. The source of the discrepancy is likely the overly aggressive folding noted in the initial report. The aggressive folding is a combination of high mixing speed as well as the lack of clearance between the rubber-edged beater blade and mixing bowl. This aggressive folding was especially detrimental to cakes baked from the experimentally milled flour in the initial report, and it appears to carry over to this data set of experimentally milled harvest composites.

The logical follow up activity would be to run additional testing with a regular beater blade at a slower mixing speed. This should reduce damage to the egg + sugar foam during flour folding and bring results between the two methods into better alignment.

Appendix A

Egg Sugar Mixture Procedure for Mechanized Folding

1. Beat eggs for 3 min at speed 1 in Hobart 12 qt. mixing bowl. Beat enough eggs for the entire day. Keep at room temperature for duration of bake.
2. Weigh 750g beaten egg and 750g sugar into a Hobart 12 qt. mixing bowl
3. Place egg-sugar mixture in ~60°C water and add thermometer. Heat the mixture until 41°C while constantly stirring with a rubber spatula. Remove from water bath.
4. Whip the heated mixture to achieve a specific gravity of 15.4-16.4g using 60 mL cup
 - a. Set timer to 6 min 45 sec.
 - b. Mix for 30 seconds at speed 1 and then switch to speed 3
 - c. Add ~150 mL (50°C water (bath set at 57.5°C)) deionized water when there are 3 min remaining
 - d. Add the rest of water when there are 2 min remaining
 - e. Mix until egg/sugar mixture achieves optimal consistency. Mixing time at speed 3 may need to be increased to achieve target specific gravity.
 - f. Turn mixer to speed 1 for the final 30 seconds
 - g. Measure egg/sugar mixture specific gravity

Mechanized Folding Method

1. Pour 264g of egg-sugar mixture into a 5 qt. bowl fitted for an 8 qt. Kitchen Aid mixer. There is enough mixture to prepare 6 cakes.
2. Attach a curved beater with rubber scraper
3. Sprinkle 110g of sifted flour in the bowl and mix for 10 seconds at speed 2 and then 10 seconds at speed 4
4. Take the bowl out of the mixer and remove the beater
5. Unload the finished cake batter (319g) into a lined pan
6. Shock the cake batter from a height of 6 cm.
7. Bake for 30 min in deck oven at both top and bottom 190°C so chamber is 180°C (356°F)
8. Drop the pan from ~20cm height
9. Grab the cake liner with two hands and remove the cake from the pan
10. Place the cake on a wired cooling rack

Appendix B
Supplementary data

Table 2. Firmness values and firmness rankings for Japanese sponge cakes baked from 2022 soft white wheat harvest composites using either the hand or mechanized folding methods.

	2022 CQ SWH Sample #	Hand Fold Firmness (g)	2022 CQ SWH Sample #	Mechanized Firmness (g)
Firm	0983	514	0983	444
	0995	396	0994	422
	0982	359	0995	414
	0986	353	0988	401
	0990	353	0992	388
	0994	340	120221005	382
	0981	338	0982	382
	0996	330	0996	378
	0985	328	0980	364
	0989	328	120221006	359
	0993	326	120221004	356
	0980	323	0979	352
	0979	312	0990	350
	120221006	308	0989	344
	0991	306	0987	343
	120221007	296	0991	343
	0987	296	120221007	332
	0984	294	0984	328
	0988	288	0981	327
	120221005	273	0986	325
	120221004	270	0993	325
Soft	0992	256	0985	320

Table 3. Total scores and total score rankings for Japanese sponge cakes baked from 2022 soft white wheat harvest composites using either the hand or mechanized folding methods.

	2022 CQ SWH Sample #	Hand Fold Total Score	2022 CQ SWH Sample #	Mechanized Total Score
Low Score	0983	36	0983	51
↓	0995	50	0994	53
	0982	51	0995	54
	0994	53	0996	55
	120221006	54	120221005	56
	0985	54	0980	56
	0986	54	0982	56
	0989	54	0988	56
	0990	54	0992	56
	0996	54	120221004	57
	0981	55	120221006	57
	0993	55	0990	57
	120221007	56	0979	58
	0980	56	0987	58
	0987	56	0989	58
	0979	57	0991	58
	0991	57	120221007	59
	0984	59	0985	59
	0988	59	0981	61
	120221004	60	0984	61
	120221005	60	0993	61
High Score	0992	62	0986	62

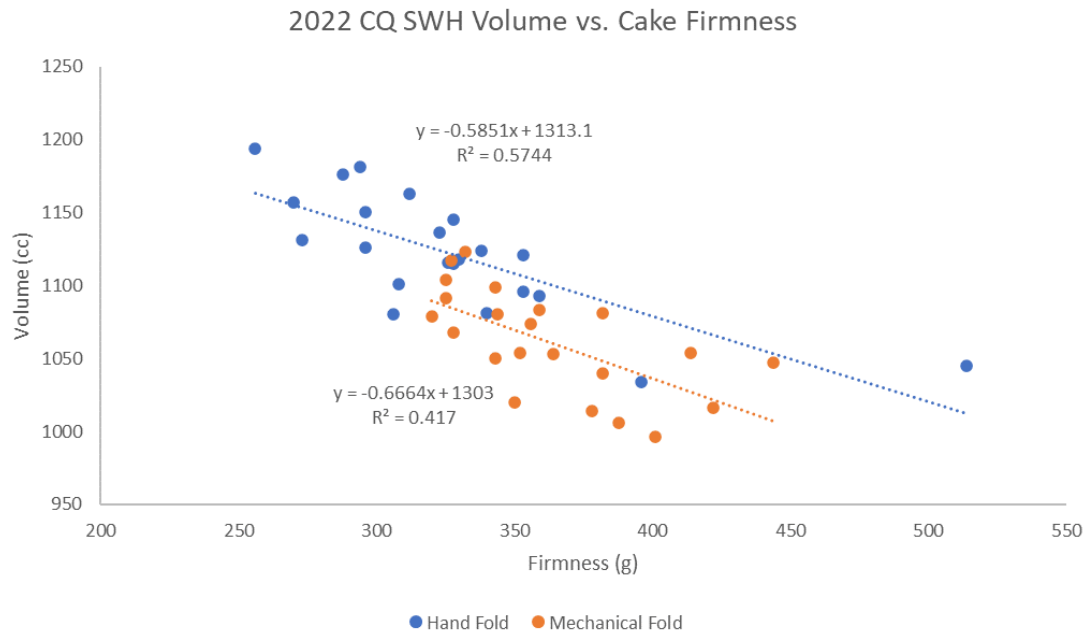


Figure 2. Relationship between firmness and volumes for Japanese sponge cakes baked from 2022 soft white wheat harvest composites using either the hand or mechanized folding methods.