U.S. Wheat Associates

Research Report
December 2023

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

Introduction

USW promotes SWH wheat across a wide variety of markets with various end products, but Japanese-style sponge cake remains the standard measurement of soft wheat performance and quality. For over 50 years USW has relied on the hand-folded sponge cake method developed in Japan by Nagao et al. (1976). This methodology is the industry standard and produces excellent end-products but relies heavily on the skill of individual technicians. Product quality can vary between technicians and laboratories given their level of training and skill.

A mechanical folding method was later developed to compensate for the potential variability among operators and allow for broader comparison of baking outcomes among labs. The mechanical sponge cake method, described by Choi et al. in 2012, suggests that the range of sponge cake volume may decrease, but overall consistency improves. The USDA Western Wheat Quality Laboratory (USDA WWQL) has adopted this method as its default Japanese sponge cake method. However, the method has not been systematically reviewed and further developed for potential standardization.

As a result, Wheat Marketing Center (WMC) completed a study in 2022 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 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 (WMC, 2022a). 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 the loss of more total cake score points for mechanically folded cakes from experimental flours despite being compared against a mechanically folded Japanese short patent control.

Further work with a full set of 2022 soft white (SWH) and club wheat samples showed a lack of agreement between Japanese sponge cakes produced by the hand and mechanized folding methods (WMC, 2022b). As a result, WMC concluded that the mechanized folding method required further refinement. This is a normal occurrence during new method development, especially when the new

method must be aligned with an existing method. The primary 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.

Mr. Bon Lee visited Nisshin and Nippn in December 2022 to pursue refinement of the initial mechanical method. The key refinements Mr. Lee identified after this visit included:

1) Switching out the rubber-edged beater blade for a standard beater blade, and
2) Folding with a slower mixer speed for a longer time period.

With these refinements identified, WMC technical staff set out to compare results among the hand, old mechanical, and new mechanical folding methods (**see Appendix A for a full description of each folding protocol**).

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.

WMC. 2022a. Development of a mechanized folding method for sponge cake production and its comparison to the traditional hand folding method. Submitted September 2022.

WMC. 2022b. Addendum – Development of a mechanized folding method for sponge cake production and its comparison to the traditional hand folding method. Submitted November 2022.

Results

(Supplemental results in Appendix B)

WMC generated two sets of composite samples for the 2023 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%)
- 13 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 both mechanized folding methods (old and new methods) within 2 weeks of the initial hand fold bake.

Volume rankings were compared across both methods as an intial 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 can 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 sample 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.

Neither mechanized folding method provides a volume ranking that corresponds to the ranking achieved by the hand folding method (see Appendix B for firmness rankings). It is evident from this data that it will not be possible to achieve consistent absolute rankings between a mechanical method and the original hand folding method given the relatively narrow range of cake volumes (~200 cc). Therefore, it is necessary to consider trend consistency (or lack thereof) among the methods.

Table 1. Volumes and volume rankings for Japanese sponge cakes baked from 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) produced using three different flour folding methods.

	Sample ID	Hand Fold Volume (cc)	Sample ID	Mechanical - Old Method Volume (cc)	Sample ID	Mechanical - New Method Volume (cc)
Low Volume	1120	990	1120	1049	1116	1076
	1122	1015	1116	1090	1120	1087
	1121	1022	1124	1094	1142	1107
	1117	1043	1117	1106	1124	1122
	1118	1062	1142	1108	1119	1133
	1116	1065	1125	1116	1121	1143
	1115	1070	1141	1127	1117	1144
	1142	1081	1115	1133	1115	1145
	1119	1082	1119	1135	1141	1148
	1114	1102	1121	1137	1125	1150
	1139	1102	1127	1139	1122	1161
	1126	1107	1122	1145	1127	1168
	1127	1112	1118	1156	1140	1182
	1123	1115	1126	1156	1114	1189
	1141	1130	1123	1157	1139	1192
	1125	1141	1140	1169	1126	1195
	1124	1154	1114	1182	1123	1212
	1140	1160	1139	1189	1118	1226
High Volume	1258	1204	1258	1225	1258	1318

In addition to ranking assignments, the relationship between protein content and cake volume was assessed for all 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). The new mechanical folding method resulted in a trendline with a comparatively similar slope to the hand folding method (i.e., the lines are almost parallel). Compared to the trend line for the old mechanical folding method, this is a marked improvement in the ability to maintain trends that are consistent between the new mechanical and hand folding methods even if the absolute rankings are not the same.

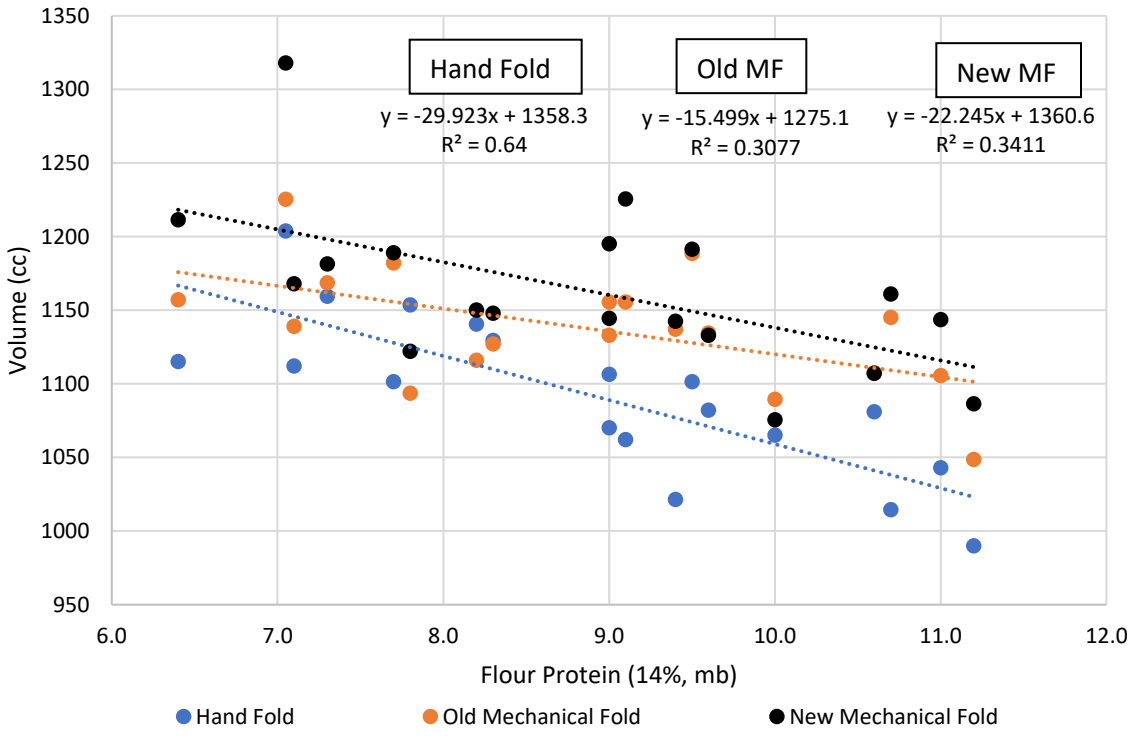

Figure 1. Relationship between volume and protein content for Japanese sponge cakes baked from 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) produced using three different flour folding methods.

The relationship between cake volume and cake firmness was also assessed for all sponge cake folding methods. It is generally expected that Japanese sponge firmness will decrease as cake volume increases. Hand folded cakes showed the expected negative correlation between cake volume and firmness (Figure 2). Again, the new mechanical folding method resulted in a trendline with a comparatively similar slope to the hand folding method (i.e., the lines are almost parallel). Combined with the trends for protein content and cake volume, this shows that the new mechanical folding method is aligned more closely

with the hand folding method and maintains well-established relationships among parameters including protein content, cake volume, and cake firmness.

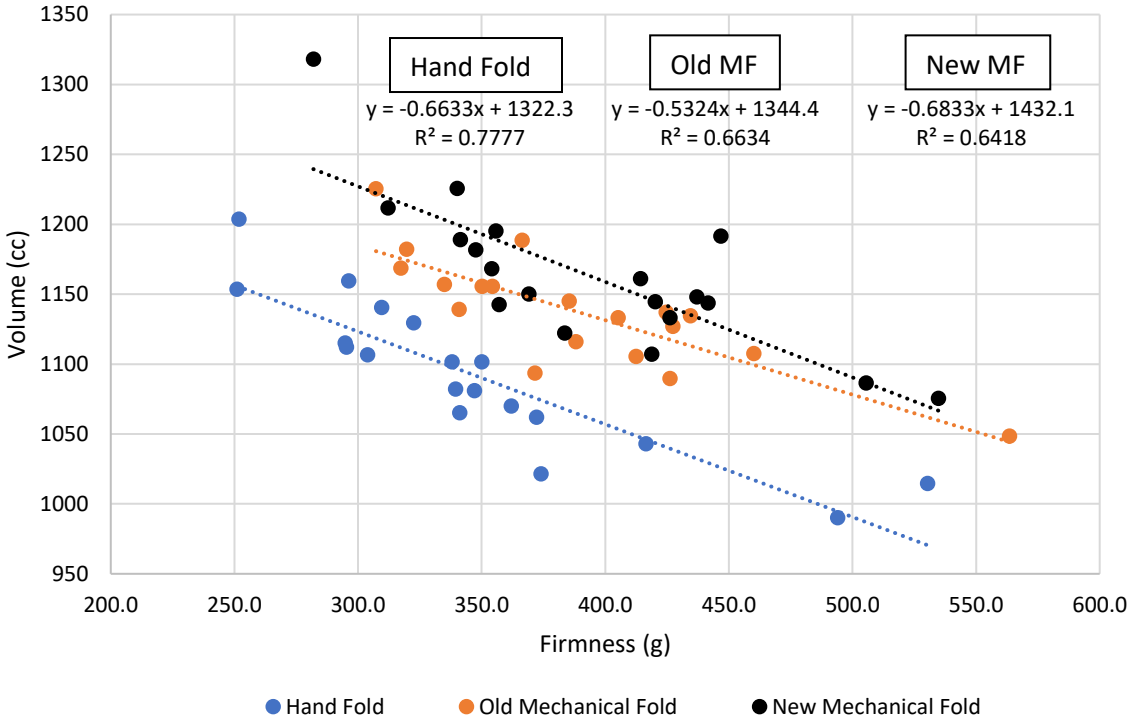

Figure 2. Relationship between volume and cake firmness for Japanese sponge cakes baked from 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) produced using three different flour folding methods.

Conclusions

The lack of agreement between Japanese sponge cakes produced between the hand and old mechanized folding method was likely due to the overly aggressive folding employed by the old mechanized method. This was noted in the initial report in 2022 as well as the associated addendum. The overly aggressive mixing resulted from a combination of a rubber-edged beater blade with limited bowl clearance and a high folding speed.

A refined method that incorporated a standard beater blade and slower folding speed was developed to reduce damage to the cake batter foam, thereby more closely imitating baking outcomes from the hand folding method. Comparison of the results among the hand, old mechanized, and new mechanized folding methods show that the new mechanized folding method more successfully replicates trends observed for the hand folding method. While absolute values and rankings are not consistent, the trends for protein content vs. cake volume and cake volume vs. firmness share similar slopes and can be considered comparable between the hand and new mechanized folding methods. As such, the new mechanized folding method is an acceptable replacement for the traditional hand folding method.

As USW considers switching to the new mechanized folding method for the CQ report, there will be differences in results between the hand and new mechanized folding methods. It is advisable to collect a second year of data wherein both the hand and new mechanized folding methods are used so that the results in this report can be validated with a new set of practically relevant samples. Additionally, if USW ultimately decides to pursue the new mechanized method for CQ reporting, hand and new mechanical folding results will need to be reported side-by-side for at least five years so that customers can see how the results differ between the methods. In this way customers can be prepared for the volume and firmness differences. Once five years of data are available to generate a five-year average for the new mechanized method, it should be possible to drop the hand folding method and proceed with only the new mechanized folding method in the CQ report.

Appendix A

Sponge Cake Procedure:

INGREDIENTS

	per cake	per batch
Flour	100 g	—
Fresh eggs	100 g	700 g
Baker's Special sugar	100 g	700 g
Deionized water	40 mL	280 mL

Preparation work:

1. Preheat all three deck ovens to 190 °C for top and bottom heat.
2. Preheat deionized water in the "water" bath set at 57.5°C.
3. Fill out the Sponge Cake Evaluation Sheet for all samples. The first batch of cakes are all WMC cake control flour (Heart by Nippn). Place 1 control in each subsequent batch moving from first through 5^{th} or 6^{th} position of the batch based on the sheet. Sift all flour samples separately and weigh each sample into a 600 mL stainless steel bowl and cover – not more than 1 day before baking. Cover the bowl with plastic bag and label properly if not being used immediately.
4. Weigh 700 g of sugar for each batch of cakes.
5. Crack all eggs that is enough for the scheduled number of batches plus one and mix for 3 minutes at speed 1. Set aside with cover at room temperature.
6. Place cake strip, then bottom liner in each cake pan for the batch.
7. Set all 9 (3 x 3) timers for 30 minutes.

To make the egg-sugar-water foam:

8. Weigh 700 g of stirred egg into 12 qt mixing bowl and add 700 g of sugar.
9. Place the mixing bowl in the 20 qt bowl filled with hot tap water.
10. Bring the temperature of egg-sugar mixture to 41.0°C while stirring with a rubber scraper.
11. Wipe the outside of mixing bowl and set it on the mixer with wire whip.
12. Set the mixer timer for 6 minutes and 45 seconds.
13. Begin mixing for 30 seconds on speed 1 (low), then turn to speed 3 (high).
14. Slowly (about 15 seconds) add about half of heated 280 mL of deionized water when 3 minutes remain on the timer.
15. Slowly (about 15 seconds) add the remaining water when 2 minutes remain on the timer.
16. Turn the mixer to speed 1 for the final 30 seconds.
17. Measure the specific gravity. The target specific gravity is 25.7-27.3 g/100 mL. Record.
18. If the specific gravity is too high, mix additional time on speed 3 followed by 30 seconds on speed 1. If it is too low, mix additional time on speed 1. If additional mixing time fails in attaining the target after three tries, discard the mixture and start again at step 9.

Hand Folding Method:

1. Weigh 240 g of egg-sugar-water foam in 3 qt. stainless steel bowls. Repeat until 6 bowls are weighed.
2. Add 100 g of sifted flour uniformly over the foam.
3. A wooden paddle is used to fold in the flour using 40 folds at slow speed with a ¼ turn every 10 folds followed by 40 folds at a fast speed with a ¼ turn every 10 folds. The first 40 folds were to incorporate the flour and the final 40 were to mix the batter thoroughly.
4. The target specific gravity is 0.45±0.02 (25.8 to 28.2 g for 60 mL cup or 43.0 to 47.0 g for 100 mL cup). Record.
5. Scrape most of the batter from the specific gravity cup and ladle back into the bowl with a rubber spatula.
6. Unload the cake batter into a lined pan, drop the pan from 6 cm height to remove large air bubbles and bake for 30 minutes.
7. Immediately after the bake, drop each cake from about 20 cm height to limit cake collapsing during cooling. Immediately remove the cake from the pan and allow to cool for 90 minutes.
8. Place the cooled cake in a white plastic container and cover it with a lid and store overnight for analysis the next day.
9. Repeat steps 1 to 8 until all samples in the batch are done.

Old Mechanical Folding Method:

1. Weigh 264 g of egg-sugar-water foam in a KitchenAid 5 qt bowl. Repeat until 5 bowls are weighed.
2. Insert a curved 5 qt. beater with rubber scraper (New Metro Design, Model # 6L-MR, Duncansville, PA) in a mixing bowl containing the egg-sugar-water foam and set the bowl on the 8 qt. KitchenAid mixer.
3. Add 110 g of sifted flour uniformly over the foam.
4. Set the mixer to speed 2 for 10 seconds, and then speed 4 for 10 seconds to fold in the flour.
5. The target specific gravity is 0.45 $\pm$ 0.02 (25.8 to 28.2 g for 60 mL cup or 43.0 to 47.0 g for 100 mL cup). Record.
6. Scrape most of the batter from the specific gravity cup and ladle back into the bowl with a rubber spatula.
7. Unload 335 g of cake batter into a lined pan, drop the pan from 6 cm height to remove large air bubbles and bake for 30 minutes.
8. Immediately after the bake, drop each cake from about 20 cm height to limit cake collapsing during cooling. Immediately remove the cake from the pan and allow to cool for 90 minutes.
9. Place the cooled cake in a white plastic container and cover it with a lid and store overnight for analysis the next day.
10. Repeat steps 1 to 9 until all samples in the batch are done.

New Mechanical Folding Method:

1. Weigh 264 g of egg-sugar-water foam in a KitchenAid 5 qt bowl. Repeat until 5 bowls are weighed.
2. Insert a flat beater in a mixing bowl containing egg-sugar-water foam and set the bowl on the 8 qt KitchenAid mixer.
3. Set the mixer to stir speed for 30 seconds. Once mixing has started, add 110 g of sifted flour. It is ideal to have all the flour added to the mixer within 5 seconds.
4. Scrape the edge of the mixing bowl as well as the flat beater with a rubber scraper and start mixing for another 40 seconds on stir speed.
5. Scrape the edge of the bowl and the flat beater with rubber scraper and measure specific gravity of the final cake batter immediately by filling the designated cup with a ladle. The target specific gravity is 0.45 ± 0.02 (25.8 to 28.2 g for 60 mL cup or 43.0 to 47.0 g for 100 mL cup). Record.
6. Scrape most of the batter from the specific gravity cup and ladle back into the bowl with a rubber spatula.
7. Unload 335 g of cake batter into a lined pan, drop the pan from 6 cm height to remove large air bubbles and bake for 30 minutes.
8. Immediately after the bake, drop each cake from about 20 cm height to limit cake collapsing during cooling. Immediately remove the cake from the pan and allow to cool for 90 minutes.
9. Place the cooled cake in a white plastic container and cover it with a lid and store overnight for analysis the next day.
10. Repeat steps from 1 to 9 for all sifted flour samples.

Appendix B

Supplementary data

Table 1. Cake volume for Japanese sponge cakes baked from 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) produced using three different flour folding methods.

Sample	Hand Fold Volume (cc)	Mechanical - Old Method Volume (cc)	Mechanical - New Method Volume (cc)
NC 8.5-9.4	$1102\pm1^{bcdef,2}$	$1182\pm10^{ab,1}$	$1189\pm7^{bcd,1}$
NC 9.5-10.4	$1070\pm4^{defgh,2}$	$1133\pm38^{bcde,12}$	$1145\pm15^{defg,1}$
NC 10.5-12.0	$1065\pm7^{defgh,1}$	$1090\pm57^{ef,1}$	$1076\pm54^{h,1}$
NC >12.0	$1043\pm11^{fghi,2}$	$1106\pm67^{cdef,12}$	$1144\pm19^{defg,1}$
NE 9.5-10.4	$1062\pm20^{efgh,3}$	$1156\pm25^{bcd,2}$	$1226\pm15^{b,1}$
NE 10.5-12.0	$1082\pm21^{cdefg,1}$	$1135\pm23^{bcde,1}$	$1133\pm8^{defgh,1}$
NE > 12.0	$990\pm38^{i,2}$	$1049\pm56^{f,12}$	$1087\pm11^{gh,1}$
C 10.5-12.0	$1022\pm47^{ghi,2}$	$1137\pm89^{bcde,1}$	$1143\pm5^{defg,1}$
C > 12.0	$1015\pm35^{hi,2}$	$1145\pm7^{bcde,1}$	$1161\pm33^{bcdef,1}$
SE < 8.5	$1115\pm6^{bcde,2}$	$1157\pm23^{bcd,12}$	$1212\pm36^{bc,1}$
SE 8.5-9.4	$1154\pm30^{ab,1}$	$1094\pm70^{def,1}$	$1122\pm24^{efgh,1}$
SE 9.5-10.4	$1141\pm22^{bc,1}$	$1116\pm91^{cde,1}$	$1150\pm44^{cdefg,1}$
SE 10.5-12.0	$1107\pm18^{bcdef,2}$	$1156\pm5^{bcd,12}$	$1195\pm33^{bcd,1}$
SW < 8.5	$1112\pm8^{bcde,1}$	$1139\pm24^{bcde,1}$	$1168\pm4^{bcdef,1}$
USW Club	$1102\pm12^{bcdef,2}$	$1189\pm25^{ab,1}$	$1192\pm5^{bcd,1}$
USW Low Protein SWH (< 9.0%)	$1160\pm23^{ab,1}$	$1169\pm16^{abc,1}$	$1182\pm36^{bcde,1}$
USW Medium Protein SWH (9.0 - 10.5%)	$1130\pm9^{bcd,1}$	$1127\pm38^{bcde,1}$	$1148\pm1^{cdefg,1}$
USW High Protein SWH (> 10.5%)	$1081\pm31^{cdefg,1}$	$1108\pm43^{cdef,1}$	$1107\pm10^{fgh,1}$
Control	$1204\pm24^{a,2}$	$1225\pm51^{a,2}$	$1318\pm24^{a,1}$

Values are means (n = 2). Different letters in the same column and different numbers in the same row are significantly different at $p < 0.05$.

Table 2. Cake specific volume for Japanese sponge cakes baked from 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) produced using three different flour folding methods.

Sample	Hand Fold Specific Volume (cc/g)	Mechanical - Old Method Specific Volume (cc/g)	Mechanical - New Method Specific Volume (cc/g)
NC 8.5-9.4	3.58±0.00^{bcdef,2}	3.85±0.01^{ab,1}	3.90±0.03^{bcd,1}
NC 9.5-10.4	3.47±0.01^{defgh,2}	3.70±0.10^{bcd,1}	3.73±0.04^{defg,1}
NC 10.5-12.0	3.44±0.03^{efgh,1}	3.54±0.18^{de,1}	3.51±0.17^{h,1}
NC >12.0	3.39±0.02^{fghi,2}	3.59±0.21^{cde,12}	3.73±0.10^{defg,1}
NE 9.5-10.4	3.42±0.06^{fgh,3}	3.78±0.08^{bc,2}	4.02±0.02^{b,1}
NE 10.5-12.0	3.51±0.04^{cdefg,1}	3.71±0.07^{bcd,1}	3.70±0.01^{defgh,1}
NE > 12.0	3.21±0.11^{i,2}	3.40±0.18^{e,12}	3.54±0.05^{gh,1}
C 10.5-12.0	3.31±0.14^{ghi,2}	3.72±0.29^{bcd,1}	3.71±0.01^{defgh,1}
C > 12.0	3.29±0.11^{hi,2}	3.73±0.05^{bcd,1}	3.78±0.11^{cdef,1}
SE < 8.5	3.63±0.05^{bcde,2}	3.78±0.07^{bc,12}	3.96±0.11^{bc,1}
SE 8.5-9.4	3.71±0.11^{abc,1}	3.55±0.23^{de,1}	3.65±0.07^{efgh,1}
SE 9.5-10.4	3.66±0.05^{bcd,1}	3.64±0.29^{cd,1}	3.74±0.14^{defg,1}
SE 10.5-12.0	3.56±0.05^{bcdef,2}	3.76±0.02^{bc,1}	3.89±0.09^{bcd,1}
SW < 8.5	3.60±0.03^{bcdef,2}	3.69±0.09^{bcd,12}	3.80±0.01^{cde,1}
USW Club	3.57±0.05^{bcdef,2}	3.87±0.08^{ab,1}	3.89±0.04^{bcd,1}
USW Low Protein SWH (< 9.0%)	3.72±0.08^{ab,1}	3.80±0.07^{abc,1}	3.84±0.11^{bcde,1}
USW Medium Protein SWH (9.0 - 10.5%)	3.64±0.05^{bcde,1}	3.68±0.13^{bcd,1}	3.73±0.01^{defg,1}
USW High Protein SWH (> 10.5%)	3.49±0.08^{defgh,1}	3.60±0.14^{cde,1}	3.58±0.07^{fgh,1}
Control	3.90±0.07^{a,2}	4.00±0.16^{a,2}	4.30±0.08^{a,1}

Values are means (n = 2). Different letters in the same column and different numbers in the same row are significantly different at $p < 0.05$.

Table 3. Cake firmness for Japanese sponge cakes baked from 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) produced using three different flour folding methods.

Sample	Hand Fold Firmness (g)	Mechanical - Old Method Firmness (g)	Mechanical - New Method Firmness (g)
NC 8.5-9.4	338.0±68.4^{cdef,1}	319.7±32.0^{ef,1}	341.4±21.4^{efg,1}
NC 9.5-10.4	362.0±56.6^{cd,1}	405.2±53.2^{bcdef,1}	420.2±78.3^{bcde,1}
NC 10.5-12.0	341.2±63.4^{cdef,2}	426.2±54.2^{bcd,2}	534.8±148.4^{a,1}
NC >12.0	416.5±0.0^{bc,1}	412.5±78.4^{bcde,1}	441.5±29.1^{abcd,1}
NE 9.5-10.4	372.2±93.9^{cd,1}	350.2±50.9^{cdef,1}	340.1±3.4^{efg,1}
NE 10.5-12.0	339.5±50.8^{cdef,1}	434.5±1.2^{bc,1}	426.2±21.3^{bcde,1}
NE > 12.0	494.0±30.7^{ab,1}	563.6±94.4^{a,1}	505.5±35.3^{ab,1}
C 10.5-12.0	374.0±44.4^{cd,1}	424.6±63.5^{bcd,1}	357.1±33.1^{cdefg,1}
C > 12.0	530.4±37.8^{a,1}	385.4±31.1^{bcdef,2}	414.3±9.3^{bcde,2}
SE < 8.5	294.8±43.4^{def,1}	335.0±58.6^{def,1}	312.1±16.9^{fg,1}
SE 8.5-9.4	251.1±34.9^{f,2}	371.6±75.4^{bcdef,1}	383.6±2.2^{cdef,1}
SE 9.5-10.4	309.6±14.1^{def,1}	388.2±111.4^{bcdef,1}	369.1±22.4^{cdefg,1}
SE 10.5-12.0	303.9±1.8^{def,1}	354.4±18.3^{cdef,1}	355.8±16.6^{cdefg,1}
SW < 8.5	295.4±54.9^{def,1}	340.9±9.1^{cdef,1}	354.1±5.7^{cdefg,1}
USW Club	350.1±18.6^{cd,2}	366.5±5.7^{bcdef,12}	446.7±5.2^{abc,1}
USW Low Protein SWH (< 9.0%)	296.2±16.7^{def,1}	317.3±18.5^{ef,1}	347.6±20.1^{defg,1}
USW Medium Protein SWH (9.0 - 10.5%)	322.5±19.0^{cdef,2}	427.4±44.8^{bcd,1}	437.0±40.1^{bcd,1}
USW High Protein SWH (> 10.5%)	347.2±50.6^{cde,2}	460.1±30.2^{b,1}	418.8±29.7^{bcde,12}
Control	251.8±25.5^{ef,1}	307.3±38.5^{f,1}	282.0±21.2^{g,1}

Values are means (n = 2). Different letters in the same column and different numbers in the same row are significantly different at $p < 0.05$.

Table 4. Japanese sponge cake batter specific gravity for 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) prepared using three different flour folding methods.

Sample	Hand Fold Specific Gravity (g/100 mL)	Mechanical - Old Method Specific Gravity (g/100 mL)	Mechanical - New Method Specific Gravity (g/100 mL)
NC 8.5-9.4	40.6	45.8	45.3
NC 9.5-10.4	42.3	50.0	50.1
NC 10.5-12.0	43.2	51.8	50.3
NC >12.0	45.8	51.8	48.7
NE 9.5-10.4	42.9	48.8	44.6
NE 10.5-12.0	40.4	51.5	49.3
NE > 12.0	40.3	55.7	51.5
C 10.5-12.0	42.8	54.1	47.0
C > 12.0	42.9	50.6	48.4
SE < 8.5	43.8	47.9	45.8
SE 8.5-9.4	40.0	52.1	49.4
SE 9.5-10.4	43.3	53.9	50.8
SE 10.5-12.0	44.7	46.2	47.2
SW < 8.5	43.9	47.5	48.5
USW Club	40.5	45.5	46.6
USW Low Protein SWH (< 9.0%)	40.7	45.5	47.5
USW Medium Protein SWH (9.0 - 10.5%)	41.9	50.4	48.3
USW High Protein SWH (> 10.5%)	42.6	51.1	50.5
Control	39.5	46.0	41.2

Table 5. Firmness and firmness rankings for Japanese sponge cakes baked from 2023 soft white wheat harvest composites and a commercially milled cake flour (Heart, milled by Nippn) produced using three different flour folding methods.

	Sample ID	Hand Fold Firmness (g)	Sample ID	Mechanical - Old Method Firmness (g)	Sample ID	Mechanical - New Method Firmness (g)
Firm	1122	530.4	1120	563.6	1116	534.8
↓	1120	494.0	1142	460.1	1120	505.5
	1117	416.5	1119	434.5	1139	446.7
	1121	374.0	1141	427.4	1117	441.5
	1118	372.2	1116	426.2	1141	437.0
	1115	362.0	1121	424.6	1119	426.2
	1139	350.1	1117	412.5	1115	420.2
	1142	347.2	1115	405.2	1142	418.8
	1116	341.2	1125	388.2	1122	414.3
	1119	339.5	1122	385.4	1124	383.6
	1114	338.0	1124	371.6	1125	369.1
	1141	322.5	1139	366.5	1121	357.1
	1125	309.6	1126	354.4	1126	355.8
	1126	303.9	1118	350.2	1127	354.1
	1140	296.2	1127	340.9	1140	347.6
	1127	295.4	1123	335.0	1114	341.4
	1123	294.8	1114	319.7	1118	340.1
	1258	251.8	1140	317.3	1123	312.1
Soft	1124	251.1	1258	307.3	1258	282.0