QUALITY CHARACTERISTICS OF SOFT WHEATS AND THEIR USE IN JAPAN. I. METHODS OF ASSESSING WHEAT SUITABILITY FOR JAPANESE PRODUCTS

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ABSTRACT

Since usages of soft wheats in the Japanese market are different from Western countries, quality requirements for them have peculiar aspects. Sponge-cake and Japanese-type noodle testing methods were found most valuable in evaluating the secondary processing quality of soft wheats. General quality evaluation of soft wheats can be derived from the combination of the results of sponge-cake and Japanese-type noodle tests, as well as by the AACC cookie test and by consideration of test milling and analytical results.

Soft wheat comprises 1.7–2.0 million metric tons/year, or about one-third of all wheat milled in Japan. Among flours consumed in Japan, those for Japanese-type wet and dry noodles, confectionery products, and a great portion of family flours are from the so-called soft wheats. Each type of flour can be estimated at about 23, 13, and 4% of total flour consumption, respectively.

Many specialty flours are produced for a variety of Japanese-type noodles and confectionery products. Although flour millers have good control of their milling techniques to meet these complicated requirements from their customers (1), wheat quality is the most important and influencing factor.

With this background, we have the following quality requirements for soft wheats: in general, grain should be sound, and it should have acceptable milling characteristics. Specifically, flour should have favorable characteristics for processing confectionery products and Japanese-type noodles. Since it is often necessary to extract both a confectionery and a Japanese-type noodle flour from the same wheat blend, it is desirable that wheats have potential for both usages. However, if a wheat has quality characteristics for only one product it is possible to use it effectively.

Methods for soft wheat and flour evaluation in the U.S. are outlined by Yamazaki (2) and Yamazaki and Lord (3). Pratt (4) describes the various quality components that are related to end-use applications, as well as those related to evaluation and selection of raw material in the U.S. flour milling industry. In the Japanese industry, special information on the characteristics for confectionery products and Japanese-type noodles is necessary, in addition to data for wheat analysis and test milling. This report describes the quality evaluation methods which we have developed and find most valuable.

MATERIALS AND METHODS

After obtaining physical and chemical analysis of the grain, including test weight, vitreous kernels, shrunken and broken kernels, damaged kernels, dockage, foreign material, moisture, and protein, each 3-kg soft wheat sample was milled by a Buhler test mill, and the total flour yield obtained. A flour of 60%

extraction was made of the first break, the first middlings, and a portion of the mixture of the second break and the second middlings flour.

Sponge-cake, cookie, and Japanese-type noodle tests are made on the 60% extraction flour, in addition to the determination of color value, protein, MacMichael viscosity, alkaline water retention capacity (AWRC), maltose value, particle size, and amylograph viscosity.

Color value is obtained by use of the Kent-Jones Colour Grader. A particle-size test is made by the Blaine method, which uses a form of sub-sieve sizer (5,6) and is approved as an official testing method in the Japanese cement industry (7). By use of the apparatus shown in Fig. 1, the air-permeating speed through compressed flour under certain conditions is measured and expressed as the specific surface (cm^2/g) of the flour. For the amylograph test, a slurry composition of 65 g flour and 450 ml pure water is used. Other tests are made by AACC approved methods (8) or by their modifications.

Sponge-Cake Testing Method

Apparatus

1. Electric mixer: Kanto-Kongoki mixer or equivalent, with water jacket. Beater speeds (rpm) are: high, 240; medium, 120. Use standard 20-qt. bowl and whip furnished with mixer (Fig. 2).
2. Baking oven: oven should be of rotary or reel type fired electrically, and capable of maintaining temperature range of $\pm 3°C$. Oven baking surface should be level.
3. Manual mixing bowl: inside dimensions, 24 cm; depth, 9.5 cm.
4. Wooden spoon: 24 cm long.
5. Baking pans: use layer pans constructed of iron sheet with inside

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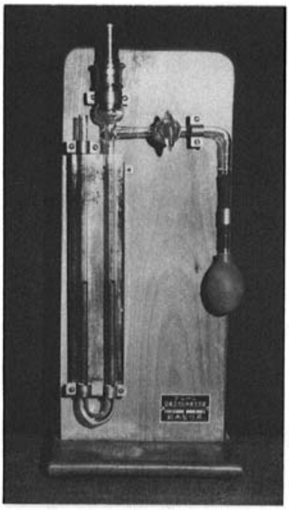

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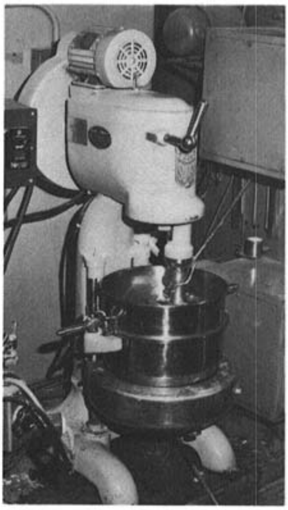

Fig. 1. Particle-size testing apparatus. Fig. 2. Mixer with whip and temperature-controlled bowl.

dimensions, 15.2 cm; depth, 6.0 cm; inside volume, 1088 ml.

6. Specific gravity measuring cup.

7. Flour sifter: use ordinary household sifter.

Formula and Ingredient Specifications

Ingredient	*Amounts* *g*	*% (flour basis)*
Flour (as-is moisture basis)	100	100
Sugar (fine-granulated sucrose)	100	100
Fresh whole egg (without shell)	100	100
Water	40	40

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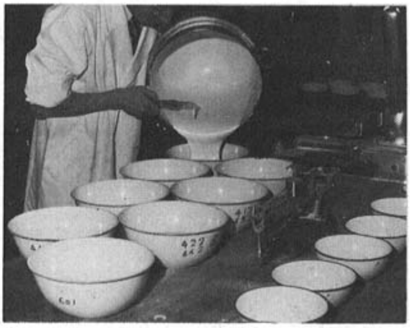

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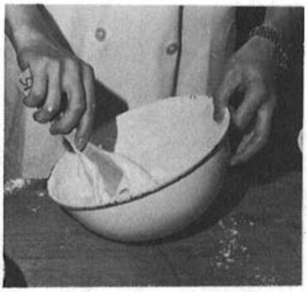

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Fig. 3. Scaling batter into manual mixing bowls. Fig. 4. Manual mixing of flour with batter. Fig. 5. Pouring finished batter into parchment-lined baking pans.

Procedure

Egg-sugar batter should be prepared in units of eight samples plus one for excess.

1. Bring oven to baking temperature (180° C).
2. Whipping: crack fresh eggs, weigh 900 g, transfer to mixing bowl, and blend by hand until just uniform, using whip attachment. Add sugar (900 g), and adjust temperature to 30° C. Whip at high speed (240 rpm) for 8–9 min. Add half the water (180 ml), whip at high speed for 2 min. Add remaining water, whip at high speed for 2 min, and finish at medium speed (120 rpm) for 1 min (Fig. 2).
3. Specific gravity of this batter should be 0.25 ± 0.01 at 30° C. Scale 240 g of batter into manual mixing bowls. Do not scrape down (Fig. 3).
4. Add sifted flour (100 g) to batter, mix by hand 60 times with a wooden spoon. Mixing should be done in a short time, and with a scooping motion (Fig. 4). Scrape down batter adhering to bowl and wooden spoon using a rubber spatula. Finally, mix batter by hand 25 times using wooden spoon, and smooth the surface.
5. Line bottom and inner side wall of baking pans with parchment paper. Pour batter into these pans (Fig. 5), and smooth surface using a plastic spatula.
6. Bake at 180°C for 30 min (Fig. 6).
7. Remove from pans immediately after baking and cool for more than 1 hr at room temperature (Fig. 7).
8. Cakes should be graded on same day as baked, or on the following day.

Measurement and Judgment Criteria

1. Obtain specific gravity of batter after whipping.
2. Observe batter characteristics.
3. Observe development in oven.
4. Weigh cakes at least 1 hr after removal from oven. (Do not remove paper.)
5. Measure volumes of cakes by rapeseed displacement or equivalent method after cooling.
6. Measure center and both edge heights.
7. Observe external factors, including shape, crust color, and crust appearance.
8. Carefully cut cake vertically through center line and observe internal factors from the standpoint of cells (uniformity, size, and thickness of walls), grain,

6

7


Fig. 6. Rotary-type electric baking oven. Fig. 7. Finished sponge cake.

TABLE I
Reference Table for Overall Scoring for Sponge Cakes, Cookies, and Japanese Noodles

Products	Items[a]	Overall Score Categories				
		9	7	5	3	1
Sponge cake	Volume[b] (ml)	1350	1250	1150	1050	950
	Both edge heights (mm)	72	67	62	57	52
	Grain	fine				coarse
	Moistness	more				less
	Tenderness	more				less
	Softness	more				less
Cookie	Width (mm)	86	83	80	77	74
	Cracking condition (top-grain)	large and deep				small and shallow
Japanese-type noodle	Yield (%)	390	370	350	330	310
	Color	bright				dark
	Eating quality	good				poor

[a]Only important items are listed.
[b]If volume is less than desired, the potential for larger volume (product development in the oven) should be taken into consideration.

texture (moistness, tenderness, and softness), crumb color, and flavor, according to AACC Method 10-90 (8).

9. Overall scoring should be done by the following scale in due consideration of all these results (9).

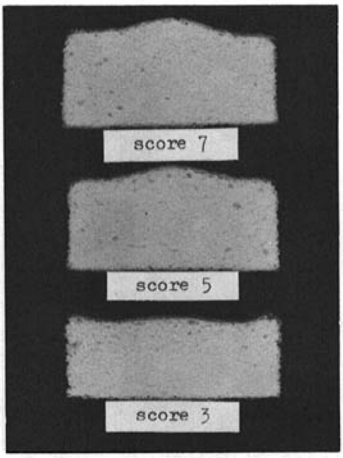
9 — much more preferable,
7 — significantly more preferable,
6 — slightly more preferable,
5 — equal to the control,
4 — slightly less preferable,
3 — significantly less preferable, and
1 — much less preferable.

Typical data for scoring sponge cake are shown in Table I. Since the product is influenced by test conditions, actual comparisons are always made in reference to suitable control bakes.

When a finished product is superior to the control in all points of volume, both edge heights, grain, moistness, tenderness, and softness, a score of 9, 8, or 7 is assigned, according to the extent. A score of 6 is assigned to the finished product which is superior to the control in some points of items described before. Scores of 4, 3, 2, and 1 are given to products which are inferior to the control, according to the extent of inferiority. Figure 8 illustrates the sponge cakes which were assigned scores 3, 5, and 7.

Cookie-Testing Method

Cookie testing is done according to AACC Method 10-50D (8). Overall scoring (Table I) should be done by the same scale as described in the sponge-cake testing method, with special consideration given to width and cracking condition (top grain) of the surface. When a finished product is superior to the control both in width and top grain, a score of 9, 8, or 7 is assigned, according to the extent. A score of 6 is assigned to the cookie which is superior to the control in either width or cracking condition. Scores of 4, 3, 2, and 1 are given to products



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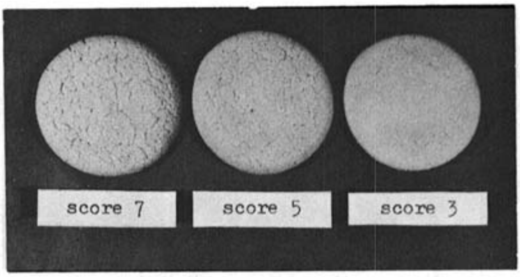

Fig. 8. Cross-sections of sponge cake showing a range of quality differences. Fig. 9. Cookies showing a range of quality differences.

which are inferior to the control. Figure 9 illustrates cookies which were assigned scores of 3, 5, and 7.

Japanese-Type Wet Noodle Testing Method

Materials

Flour (as-is moisture basis): 500 g.

Salted water: water containing 1% salt to flour is used. Amount of salted water should be adjusted according to protein content of the sample, but in the usual case 32 parts of salted water should be added to 100 parts of flour.

Soy-sauce soup for eating test.

Apparatus

1. Electric mixer: Hobart mixer, Model C-100T or equivalent.
2. Noodle testing machine: Ohtake noodle testing machine furnished with a pair of sheeting rolls and a pair of cutting rolls (Fig. 10). Sheeting rolls are 180 mm in diameter and 150 mm in width, with adjustable gap. Among many available cutting rolls, the square groove which is 3.0 or 2.5 mm wide is usually used.
3. Gas cooking-furnace.
4. Wire-netting basket divided into four or six sections.
5. Aluminum pot for boiling.
6. Plates for eating test.

Noodle Processing

1. Mixing of materials: wheat flour and 1% salted water are mixed in the Hobart mixer for 5 min. Dough prepared in this stage is very stiff and easily crumbled.
2. A dough sheet is first prepared by passing through the rolls, then two of the sheets are put together through the rolls to complete dough formation. After this operation is repeated once more, a single sheet is put through the sheeting rolls

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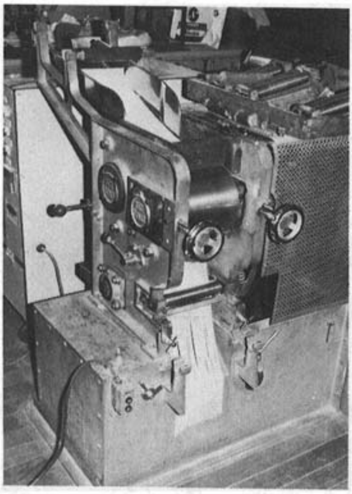

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Fig. 10. Japanese-noodle testing machine furnished with sheeting and cutting rolls. Fig. 11. Noodle-cooking apparatus showing samples in wire-netting baskets.

twice. The gap of rolls should be adjusted to 3.0 mm.

3. Finished sheet is cut through cutting rolls.

Noodle Cooking

1. Place 100 g of dough strings in each of the wire-netting baskets divided into four or six sections. Immerse basket into the aluminum pot filled with boiling water on the gas cooking-furnace (Fig. 11) and cook for 20 min. Cooking time may be adjusted by inspecting the weight, masticatory feeling (softness or tenderness), and superficial structure of cooked samples.

2. After cooked samples are removed from the basket, they are washed with cold water. Within 30 min, they are measured and judged.

Measurement and Judgment

1. Weight and volume of cooked sample are measured. Volume is determined by the water-displacement method, which uses a volumetric cylinder.

2. Calculate yield as follows:

$$\text{yield (\%)} = \frac{\text{wt of cooked noodle (g)}}{\text{dough wt (g)}\left(\dfrac{\text{flour ratio (100)}}{\text{flour ratio (100)} + \text{salted water ratio (32)}}\right)} \times 100 =$$

where: wt of cooked noodle = variable
dough weight = 100 g
salted water ratio = 32 (or variable)

Sample calculation:

$$\text{yield \%} = \frac{270\ \text{g}}{100\ \text{g}\left(\dfrac{100}{132}\right)} \times 100 = 356.4\%$$

3. Superficial structure (smoothness, adhesiveness) and color are observed.

4. Eating quality (mainly masticatory feeling like softness or tenderness) is judged by eating cooked noodles soaked in soy-sauce soup.

5. Overall scoring should be done by the same scale as described in the sponge-cake and cookie-testing methods. When a finished product is superior to the control in all points of yield, color, and eating quality, a score of 9, 8, or 7 is assigned, according to merit (Table I). A score of 6 is given to the noodle which is superior to the control in some point. Lower scores are given to products which are inferior to the control. Each 10% increase or decrease in yield from the control is equivalent to one merit or demerit point.

RESULTS AND DISCUSSION

Data for vitreous kernels, protein, color value, MacMichael viscosity, AWRC, maltose value, and particle size are considered in evaluating characteristics for confectionery products and Japanese-type noodles. Less vitreous kernels, low protein content, low MacMichael viscosity, small hydration capacity, low maltose value, and fine particle size are desirable for confectionery products. On the other hand, moderate protein content and clear color are desirable for Japanese-type noodles.

In practice, soundness of the grain is judged from the data for shrunken, broken, and otherwise damaged kernels and from amylograph viscosity. Low amylograph viscosity indicates potential harm to sponge cakes by the dropping of centers during cooling, to the noodle making process, and to the taste of the finished products. Milling quality, which is also an important criterion, can be estimated by the data for test weight, dockage, foreign material, moisture, color value, and test milling. Considering the practice in Japanese flour milling, a flour of 60% extraction composed of the first break, the first middlings, and a major portion of the mixture of the second break and the second middlings flour is better than a straight flour as a sample for testing the suitability for confectionery products and Japanese-type noodles. Test-milling condition should be adjusted to achieve the 60% extraction flour from the four mill streams described above. Adding third break and middlings flour to obtain 60% extraction is not desirable.

Formula and ingredient specifications for cake-baking described in AACC Method 10-90 (8) are not common in the Japanese market. We found that the formula and ingredient specifications reported in this paper were more suitable for evaluating cake-baking quality considering the usage of cake flour in Japan.

When fresh eggs are used, the eggs and sugar should be whipped in one lot before the flour is added. We obtained information on mixing behavior of flour subjectively, through the hand of a well-trained technician. These two steps are most important and must be done carefully. A control sample is necessary for comparison, because volume or quality of finished sponge-cake may be influenced by the testing condition or the quality characteristics of ingredients. In the case of unchlorinated flour samples, centers of cakes may drop slightly after removal from oven. In such cases, judgment should be made considering product development in the oven. Among the more important items of measurement and judgment are volume, edge heights, and appearance of internal grain and texture.

Width and cracking condition of the surface were found most valuable for judging the cookie-baking quality. In Japan, biscuits are classified into hard biscuits and soft biscuits. Unlike the situation in the U.S., only certain soft biscuits which are made by a richer-than-normal formula are called "cookies." The suitability for hard biscuits, soft biscuits, and cookies was reflected more in width than in spread factor ($W/T \times 10$). Dividing by thickness often led to false judgments, because the difference of thickness was not always related to the suitability for biscuits and cookies. Large and deep cracking of the surface suggests high potentiality of the material for use as confectionery flour.

It is desirable to repeat the noodle test at optimum conditions after determining the suitable amount of salted water and boiling time. However, the use of estimated amount of salted water and boiling time are satisfactory when we know the general characteristics of the flour sample. Although we believe eating quality to be the primary criterion for acceptance, judgment of it has many problems. Japanese-type noodles can be classified into sou-men (very thin noodle), hiya-mugi (thin noodle), udon (standard noodle), and himo-kawa (flat noodle), according to the width of noodle strings. Furthermore, there are wide variations of Japanese-type noodles due to locality, manufacturing method, and the difference of people's taste. Selection of panel members who are suitable for the testing purpose is most important. Generally speaking, softness and tenderness combined with some extent of elasticity in masticatory feeling are evaluated highly. We believe it will not be possible to replace the eating test by machine methods.

Which of the three test results should we prefer? That decision depends upon the usage of the flour, but all three should be considered in the general evaluation of soft wheat quality. When a sample shows favorable characteristics for only one or two of the tests, potential usage will be limited. The sponge-cake test is more important than the cookie test for evaluating the usage of confectionery flour in Japan.

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