Baking Quality of Cookie Flour—Micro Method

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Objective

In North America, "cookie" is a product similar to what is internationally known as "biscuit." Cookie quality is determined (in two sugar-snap cookies) by width (*W*) and thickness (*T*), with adjustments to constant atmospheric pressure and conditions. The formulation uses 40 g of flour, in a small pin mixer, and a variable amount of water added to dough. Nonfat dried milk is used to aid in developing brown color. This method predicts the general quality of soft wheat flour for production of contemporary cookie and pastry products (except cake and crackers). High quality of pastry flours is usually associated with larger sugar-snap cookie diameter. The method is also useful to evaluate other flour types, various flour treatments, and other factors, such as ingredients, that affect cookie geometry.

Apparatus

1. National cookie dough micromixer, with head speed of 172 rpm and special cookie dough bowl.

2. Electric mixer, with timer control. Use appropriate beater furnished with mixer.

3. Aluminum cookie sheet, 3003-H14 aluminum alloy, about 2.0 mm (0.08 in.) thickness, size 30.5 × 40.6 cm (12 × 16 in.) or 25.4 × 33.0 cm (10 × 13 in.), or other sizes required to accommodate oven doors and shelves. See Note 1.

4. Metal gauge strips, two, 7 mm (0.275 in.) thick and length of baking sheets. Strips can be attached to long edges of sheets. Strips should be kept clean of any buildup of grease residue. See Note 1.

5. Rolling pin, 5.7–7.0 cm (2.25–2.75 in.) diameter. If wood, check often for any wear to edges from rolling along gauge strips.

6. Cookie cutter, 60 mm inside diameter. See Note 1.

7. Small plastic spatula, ground flat at end with notch cut to fit mixing bowl pins.

8. Thermometer, hygrometer (see Note 2), and barometer.

9. Baking oven, reel or rotary, with hearth consisting of ceramic-fiber-reinforced structural alumina refractory product (6.4 mm [¼ in.] thick) as shelf liner cut to dimensions of and placed on steel baking shelf. Oven shelves consisting of wire mesh baking surface are also suitable and may not need shelf liner (to prevent excessive bottom browning). Oven should be electrically heated and capable of maintaining temperature range of ±2 at 205° (±5 at 400°F).

Reagents

1. Solution A. Dissolve 79.8 g sodium bicarbonate ($NaHCO_3$) in distilled or deionized water and make to 1 liter.

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2. Solution B. Dissolve 101.6 g ammonium chloride (NH_4Cl) and 88.8 g NaCl in distilled or deionized water and make to 1 liter.

If sealed tightly, reagents can be kept for several months.

Procedure

Formula

Ingredients at 21 ± 1° (70 ± 2°F)	*Weight (g)*
Flour, 14% moisture basis (see Note 3, Table I)	40.0
Sugar, "baker's special" (see Note 4)	24.0
Shortening (see Note 5)	12.0
Nonfat dry milk (see Note 6)	1.2
Sodium bicarbonate ($NaHCO_3$)	0.40
Sodium bicarbonate (in solution A)	0.32
Ammonium chloride (NH_4Cl) (in solution B)	0.20
NaCl (in solution B)	0.18
Deionized water	variable

Method

1. Sift together sugar, nonfat dry milk, and sodium bicarbonate (of appropriate batch size for day's bake, see Note 7, Table II) eight times. Cream these ingredients together with shortening with mixer on low speed 1 min, then scrape; on medium speed 1 min, then scrape; on high speed 30 sec, then scrape; and on high speed 30 sec. Weigh 37.6-g portions of this creamed mass.

TABLE I
Weights of Flour at Various Moisture Contents Corresponding to 40-g Flour Weight at 14% Moisture Basis

Flour Moisture (%)	Flour Weight (%)	Flour Moisture (%)	Flour Weight (%)
12.0	39.1	13.3	39.7
12.1	39.1	13.4	39.7
12.2	39.2	13.5	39.8
12.3	39.2	13.6	39.8
12.4	39.3	13.7	39.9
12.5	39.3	13.8	39.9
12.6	39.4	13.9	40.0
12.7	39.4	14.0	40.0
12.8	39.4	14.1	40.0
12.9	39.5	14.2	40.1
13.0	39.5	14.3	40.1
13.1	39.6	14.4	40.2
13.2	39.6	14.5	40.2

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2. Scrape 37.6 g creamed mass into cookie dough mixing bowl. Add 4.0 ml solution A, 2.0 ml solution B, and appropriate amount of water to achieve optimum dough consistency (see Note 8, Table III). Dough consistency should be consistent from flour to flour. Water amount should be such that dough does not usually stick to rolling pin. See Note 2. Mix 3 min (stopping mixer and scraping after first few sec if shortening is stuck on side of bowl) and scrape with small spatula.

TABLE II
Ingredient Weights (g) for Batch Sizes of 20–45 Batches

	Number of Units to be Baked					
Ingredient	**20**	**25**	**30**	**35**	**40**	**45**
Sugar	504.0	624.0	744.0	864.0	984.0	1104.0
Nonfat dry milk	25.2	31.2	37.2	43.2	49.2	55.2
Sodium bicarbonate	8.4	10.4	12.4	14.4	16.4	18.4
Shortening	252.0	312.0	372.0	432.0	492.0	552.0

TABLE III
Starting Guide for Gauging Optimum Dough Water Level

Soft Wheat Flour Protein Range (%)	Starting Water Absorption[a,b] (ml)
4.4–5.1	0.3
5.2–5.9	0.4
6.0–6.6	0.5
6.7–7.3	0.6
7.4–8.1	0.7
8.2–8.8	0.8
8.9–9.6	0.9
9.7–10.3	1.0
10.4–11.0	1.1
11.1–11.8	1.2
11.9–12.5	1.3
12.6–13.2	1.4
13.3–14.0	1.5
14.1–14.8	1.6
14.9–15.5	1.7
15.6–16.3	1.8
16.4–17.0	1.9
17.1–17.8	2.0
17.9–18.5	2.1

[a]For hard wheat flours, add 0.7 ml to amount listed in table.

[b]Doughs that are too dry will be crumbly and may stick to rolling pin. Doughs that are too wet will not have firm feel and may also be sticky.

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3. Add flour to mixing bowl. Mix 10 sec while tapping side of bowl. Scrape dough from mixer and bowl pins; scrape outer edge and bottom of bowl, pushing dough between pins several times. Mix 5 sec and scrape as just described. Mix 5 sec and scrape. Mix 5 sec and scrape mixer pins.

4. Gently scrape dough from bowl and cut with spatula into two equal portions. See Note 9. Transfer to lightly greased cookie sheet. Using gauge strips, roll to thickness with one forward rolling pin stroke and one return (backward) stroke. Cut dough with cookie cutter, discard excess dough, and remove cutter. Immediately place in 205° (400°F) oven and bake for 11 min. See Note 10.

5. On removal from oven, cool 5 min and remove cookies from baking sheet with nonstick coated utensil. Wipe baking sheet with damp towel to remove

TABLE IV
Correction Factors for Adjusting Width (as-is) to Constant Atmospheric Pressure Basis

Laboratory	Barometric Pressure—inches of Hg (Corrected to Sea Level)						
Elevation (feet above sea level)	**29.31 to 29.50**	**29.51 to 29.70**	**29.71 to 29.90**	**29.91 to 30.10**	**30.11 to 30.30**	**30.31 to 30.50**	**30.51 to 30.70**
0–100	0.993	0.995	0.997	1.000	1.002	1.005	1.007
101–300	0.990	0.993	0.995	0.997	1.000	1.002	1.005
301–500	0.988	0.990	0.993	0.995	0.997	1.000	1.002
501–700	0.986	0.988	0.990	0.993	0.995	0.997	1.000
701–900	0.983	0.986	0.988	0.990	0.993	0.995	0.997
901–1100	0.981	0.983	0.986	0.988	0.990	0.993	0.995
1101–1300	0.978	0.981	0.983	0.986	0.988	0.990	0.993
1301–1500	0.976	0.978	0.981	0.983	0.986	0.988	0.990
1501–1700	0.974	0.976	0.978	0.981	0.983	0.986	0.988
1701–1900	0.971	0.974	0.976	0.978	0.981	0.983	0.986
1901–2100	0.969	0.971	0.974	0.976	0.978	0.981	0.983
2101–2300	0.967	0.969	0.971	0.974	0.976	0.978	0.981
2301–2500	0.964	0.967	0.969	0.971	0.974	0.976	0.978
2501–2700	0.962	0.964	0.967	0.969	0.971	0.974	0.976
2701–2900	0.959	0.962	0.964	0.967	0.969	0.971	0.974
2901–3100	0.957	0.959	0.962	0.964	0.967	0.969	0.971
3101–3300	0.955	0.957	0.959	0.962	0.964	0.967	0.969
3301–3500	0.952	0.955	0.957	0.959	0.962	0.964	0.967
3501–3700	0.950	0.952	0.955	0.957	0.959	0.962	0.964
3701–3900	0.948	0.950	0.952	0.955	0.957	0.959	0.962
3901–4100	0.945	0.948	0.950	0.952	0.955	0.957	0.959
4101–4300	0.943	0.945	0.948	0.950	0.952	0.955	0.957
4301–4500	0.941	0.943	0.945	0.948	0.950	0.952	0.955
4501–4700	0.939	0.941	0.943	0.945	0.948	0.950	0.952
4701–4900	0.936	0.939	0.941	0.943	0.945	0.948	0.950
4901–5100	0.934	0.936	0.939	0.941	0.943	0.945	0.948

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grease. Wash it in warm nonsoapy water, dry thoroughly, and allow to come to room temperature before next use. See Note 1.

6. Measure cookie spread after cookies have cooled to room temperature (about 30 min). Evaluate cookie top grain. See Note 11.

Calculations

After cookies have cooled to room temperature (about 30 min), lay two cookies edge to edge and measure width. Rotate them one quarter turn and remeasure. Repeat twice more. Cookie width is mean of the four measurements multiplied by appropriate correction factor for laboratory altitude and barometric pressure. See Table IV. If height measurement is also desired, stack cookies on top of each other and measure height. Read to nearest ½ mm at center of top

TABLE V
Correction Factors for Adjusting Thickness (as-is) to Constant Atmospheric Pressure Basis

Laboratory	Barometric Pressure—inches of Hg (Corrected to Sea Level)						
Elevation (feet above sea level)	29.31 to 29.50	29.51 to 29.70	29.71 to 29.90	29.91 to 30.10	30.11 to 30.30	30.31 to 30.50	30.51 to 30.70
0–100	1.013	1.008	1.004	1.000	0.996	0.992	0.987
101–300	1.017	1.013	1.008	1.004	1.000	0.996	0.992
301–500	1.021	1.017	1.013	1.008	1.004	1.000	0.996
501–700	1.025	1.021	1.017	1.013	1.008	1.004	1.000
701–900	1.030	1.025	1.021	1.017	1.013	1.008	1.004
901–1100	1.034	1.030	1.025	1.021	1.017	1.013	1.008
1101–1300	1.038	1.034	1.030	1.025	1.021	1.017	1.013
1301–1500	1.042	1.038	1.034	1.030	1.025	1.021	1.017
1501–1700	1.047	1.042	1.038	1.034	1.030	1.025	1.021
1701–1900	1.051	1.047	1.042	1.038	1.034	1.030	1.025
1901–2100	1.055	1.051	1.047	1.042	1.038	1.034	1.030
2101–2300	1.059	1.055	1.051	1.047	1.042	1.038	1.034
2301–2500	1.064	1.059	1.055	1.051	1.047	1.042	1.038
2501–2700	1.068	1.064	1.059	1.055	1.051	1.047	1.042
2701–2900	1.072	1.068	1.064	1.059	1.055	1.051	1.047
2901–3100	1.076	1.072	1.068	1.064	1.059	1.055	1.051
3101–3300	1.081	1.076	1.072	1.068	1.064	1.059	1.055
3301–3500	1.085	1.081	1.076	1.072	1.068	1.064	1.059
3501–3700	1.089	1.085	1.081	1.076	1.072	1.068	1.064
3701–3900	1.093	1.089	1.085	1.081	1.076	1.072	1.068
3901–4100	1.098	1.093	1.089	1.085	1.081	1.076	1.072
4101–4300	1.102	1.098	1.093	1.089	1.085	1.081	1.076
4301–4500	1.106	1.102	1.098	1.093	1.089	1.085	1.081
4501–4700	1.110	1.106	1.102	1.098	1.093	1.089	1.085
4701–4900	1.114	1.110	1.106	1.102	1.098	1.093	1.089
4901–5100	1.119	1.114	1.110	1.106	1.102	1.098	1.093

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cookie. Turn and restack in different order and remeasure height. Cookie height is mean of the two measurements multiplied by appropriate correction factor for laboratory altitude and barometric pressure. See Table V.

Notes

1. Cookie sheets are purchased with gauge strips fastened to the long edges of sheets.) New cookie sheets may be conditioned by lightly greasing and placing in hot oven for 15 min, cooling, and repeating this process two or three more times. Cookie sheets should be washed while warm in water (without any soaps or detergents) and wiped dry after each bake to prevent buildup and blackening of oil on their surface.

2. Dough consistency and stickiness and cookie spread are affected by temperature and humidity. Room and ingredient temperature of 21 ± 1° (70 ± 2°F) and relative humidity of 30–50% are recommended. Data variance is increased by conditions in excess of those recommended.

3. Flour moisture below 12% makes judgment of dough consistency difficult and can cause cookies to become unround and have altered top grain appearance. Amount of flour to use for 40 g at 14% moisture basis is given in Table I.

4. Only throughs of U.S. No. 30 (600-μm openings) wire sieve of any brand of "baker's special" sugar should be used.

5. Shortening should be hydrogenated, all-vegetable fat of nonemulsifer type, not containing methyl silicone, and having medium consistency. It should have solid fat index (SFI) profile as determined by dilatometric method:

Temperature (°C)	*SFI*
10.0	28–33
21.1	18–22
33.3	11–16
40.0	8–12

6. Nonfat dry milk should be ground, if necessary, to pass through a U.S. No. 30 (589-μm openings) wire sieve.

7. For relatively consistent mixing action, recommended cream mass batch size is 20–45 units. Take amounts of sugar, nonfat dry milk, sodium bicarbonate, and shortening for batches of 20–45 from Table II.

8. Starting guide for amount of water, relative to soft wheat flour protein content, needed to achieve optimum dough consistency is given in Table III. Doughs should usually have only enough liquid to give them just enough adhesion to form dough during mixing. Doughs should feel dry and not sticky to touch and should not stick to rolling pin. Wetter doughs tend to increase data variance.

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9. Operators should wash their hands to remove any hand creams and should avoid excessive handling of dough. Increased data variance due to disparate cookie weights, resulting from uneven dough weights, can be reduced by scraping all dough from mixing bowl into cylinder of approximately 65 mm diameter and gently pressing dough in cylinder with flat plunger of slightly less diameter to produce fairly uniform dough density. Plunger and cylinder are removed, and formed dough piece is cut in half at diameter. Each dough half is placed on cookie sheet and rolled as described.

10. Oven should be warmed to temperature with oven shelves turning. Bake "dummy" cookies out of scrap dough or extra flour to condition oven before making test bake at beginning of baking series or if oven has not been used for 15 min.

11. Top grain is "islanding" pattern on top surface of cookie. Besides being a varietal trait of wheat, absent or unusual top grain can indicate faulty mixing, excessive dough handling, high temperature and humidity, low oven humidity, ingredient variation, or crop year differences.

References

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