Online evaluation of masses & batters

PART 1 – HOW DO CHANGES IN THE RATIO OF INGREDIENTS IN A RECIPE AFFECT THE VISCOSITY AND CONSISTENCY OF BATTERS AND THE RESULTING POUND AND SPONGE CAKES AND HOW CAN THESE INFLUENCES BE MEASURED?

Part 2: The influence of the changes on the processing parameters will be published in the next issue of baking+biscuit international. +++

For his diploma thesis, Lars Wiebensohn prepared sponge and pound cake batters with varying amounts of raw materials. He then determined the impact of the variations in real time measurements online with the Farinograph®-E from Brabender. The torque of the beater was taken as the measured variable for such changes and recorded as a function of time.

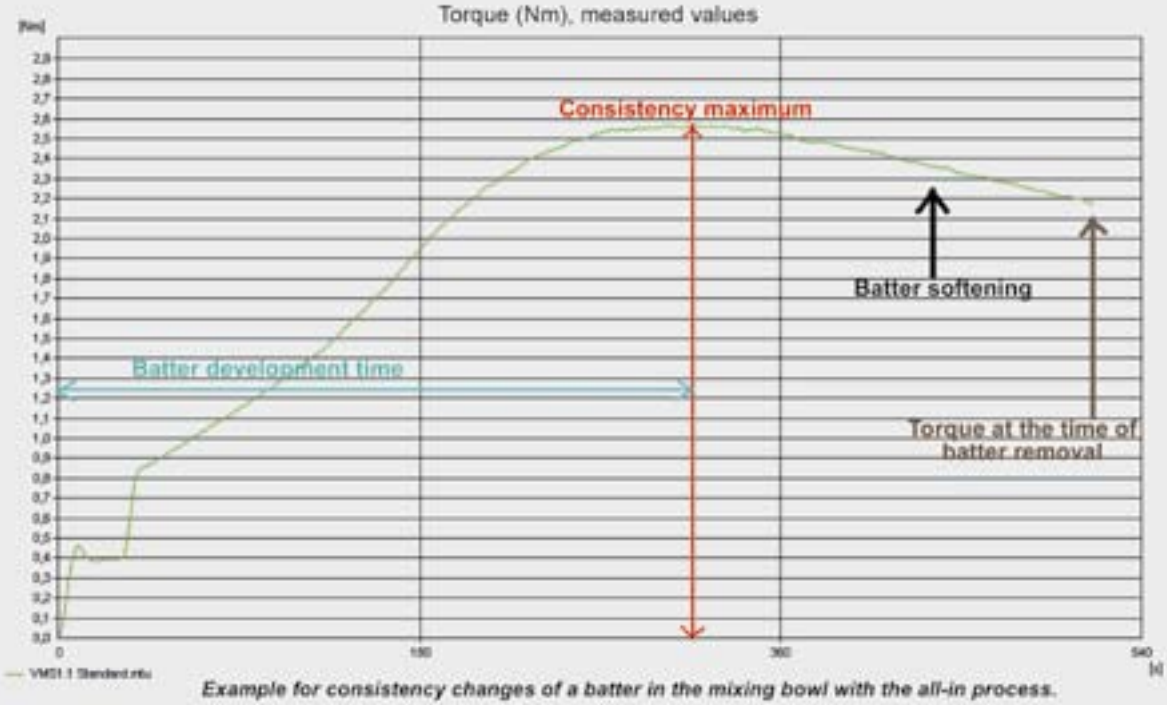
The Farinograph-E is a computer controlled measurement system for the determination of the mixing properties of wheat or rye dough, for the determination of flour quality and for identifying the processing properties of dough. This type of measurement is defined in international standards (ICC-Standard 115/1, ISO 5530-1, AACC-Standard Nr. 54-21). The Farinograph-E with USB port can be controlled via PC;

Table 1: Standard recipe for sponge cake batter

Standard baking test	Weight (g)	Parts (calculated on the amount of milled cereal products)
Wheat flour, type 550 (all purpose flour)	82	50
Wheat starch	82	50
Shortening	–	–
Sugar, fine	132	80
Whole egg (28-30 °C)	228	139
Water (20 °C)	51	31
Whipping agents (Spongolit)	17	10,4
Baking agent	7,5	4,6
Salt	1,0	0,6
Calculated weight of the mass	600	

Table 2: Standard recipe for pound cake batter

Standard baking test	Weight (g)	Parts (calculated on the amount of milled cereal products)
Wheat flour, type 550 (all purpose flour)	77	50
Wheat starch	77	50
Shortening	92	60
Sugar, fine	123	80
Whole egg (28-30 °C)	100	65
Water (20 °C)	22	14
Whipping agents (Spongolit)	5	3,2
Baking agent	3	1,9
Salt	1	0,6
Calculated weight of the mass	500	



Example for consistency changes of a batter in the mixing bowl with the all-in process.

More details

How do changes in recipe and processing parameters, for example, batter temperature, mixing and whipping times or the speed of the mixing tool influence the quality of sponge and pound cakes? Two students from the University of Applied Sciences Lippe and Höxter, Germany, attempted to answer these questions in their diploma theses. In this issue, we will introduce to you the results found for recipe changes. The work on changing processing parameters and their effects will be printed in our next issue. If you are interested in more details, please visit our website www.bakingbiscuit.com or contact Markus Löns of the Brabender Company at markus.loens@brabender.com +++

the speed is infinitely variable between 2 and 200 min^{-1}. A batter or mass is produced under defined conditions in the Farinograph planetary mixer P 600. The measuring principle is based on the resistance of the dough that is mixed with the beater. This resistance is measured as torque (Nm) and depicted as a measure of the viscosity and consistency of the batter. The measuring signal is digitalized in the Farinograph-E and transferred to the computer via the USB interface.
The test results are recorded by the computer and displayed in real time graphically or numerically.

For all trials, Wiebensohn followed the all-in method where all ingredients are filled into the whipping bowl prior to the start of mixing. The recipe ingredients were automatically mixed and then aerated with the introduction of a high amount of energy. After removal from the bowl, the batters were divided into 500 g portions (pound cake batters: 400 g), filled under defined conditions into baking pans, baked and finally cooled down on perforated sheets. The quality of the baked goods was assessed 24 hours after the production.

Test series with sponge cake batter

Test series 1 comprised five double tests. Based on the standard recipe for sponge cake batter, the amount of whole egg was successively reduced by 20 g each time and the amount of wheat flour and wheat starch was increased by 10 g each time so that the total weight was always the same.
In test series 2, the aerating agent Spongolit was reduced while flour and starch were increased. In test series 3 the flour and starch proportions were varied; in test series 4 the amount of whole egg was reduced and the amount of water increased accordingly while finally in test series 5 the changes occurring with increasing sugar contents were investigated. In the following, the results from test series 5 are discussed.

Increase in sugar content (all-in method)

The amount of sugar in test 1 was 80 parts (baker's percent), in test 2 it was 120 parts and in test 3 it was 160 parts.

The graph shows the development of the torque: red lines of the first double test, brown lines of the second double test and green lines of the third double test.

Table 3: Batter development time and consistency maximum 1-3 (increase in sugar content – all-in method)

All-in method baking test no	1	2	3
Development time of the batter (s)	330	330	360
Consistency maximum (Nm)	2.55	3.1	3.35

From one test to the other, the consistency maximum and the batter development time increased in a non-uniform pattern.

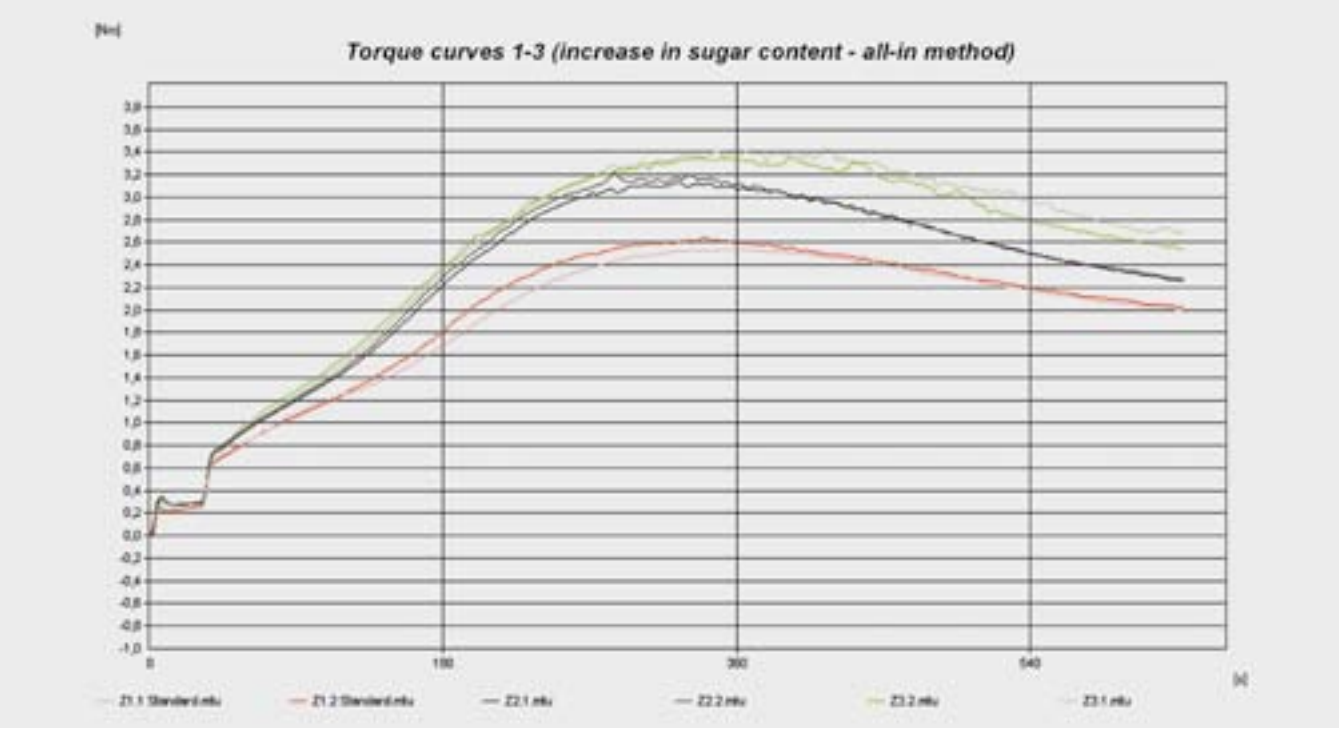
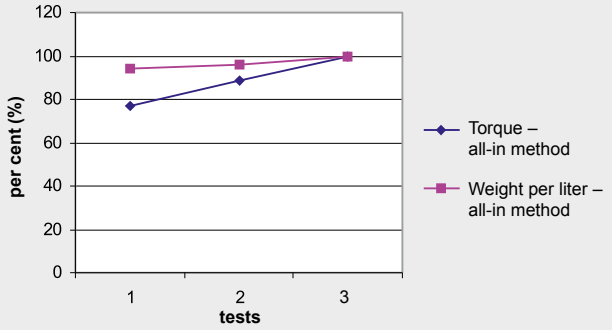


Table 4: Sponge cake batter test 1-3 (increase in sugar content – all-in method)			
Baking test no	**1**	**2**	**3**
Torque at the time of batter removal (Nm) ≙ per cent (%)	2.0 ≙ 76.9	2.3 ≙ 88.5	2.6 ≙ 100
Weight per liter (g/l) ≙ per cent (%)	330 ≙ 94.0	336 ≙ 95.7	351 ≙ 100
Weight of baked goods (g)	416.1	425.2	423.2
Loss on baking (%)	464	478	437
Volume of baked goods (ml)	2320	2390	2185
Volume yield (ml/100g batter)	464	478	437
Specific volume (ml/g baked goods)	5.6	5.6	5.2

For improved clarity, the torque values and the weights per liter are displayed graphically for tests 1-3 in per cent. It can be seen that with increasing sugar quantities the torque as well as the weight per liter are also increasing. In this case, the increase in weight per liter resulted in a decreasing volume of the baked goods as can be seen from the tables.

Graphical depiction of the torque values and the weights per liter in per cent for tests 1-3 (increase in sugar content – all-in method)



The following table shows the results of the sensory evaluation of the sponge cakes. The higher the sugar content, the more deviating is the appearance of the product from the standard because the surface takes up a strong brown color and becomes more porous. The crumb's moisture increases. At a sugar content of 160 parts (baker's percent); the chewing impression is sweet with a tendency to clump.

Table 5: Sensory evaluation of sponge cakes 1-3 (increase in sugar content – all-in method)			
All-in method baking test no	**1**	**2**	**3**
Appearance	typical	slightly deviating	deviating
Surface	smooth	smooth	porous
Browning	normal	strong	very strong
Sliceability	not crumbly	crumbly	crumbly
Leavening	aerated	aerated	aerated
Pore pattern	fine/medium	medium/ medium	medium/ medium
Color of the crumb	yellowish	yellowish	yellowish
Crumb characteristics	soft/moist	soft/moist	soft/very moist
Chewing impression	soft	soft	tendency to clump
Taste	perfect	perfect	sweet

With increasing sugar content, the torque at the time of batter removal and the weight per liter also increase while the weight of the baked good and the volume of the baked good almost remain constant. Too much sugar results in a moist crumb, too strong a color and a porous surface of the baked good, caused by the Maillard reaction.

With increasing sugar content, in particular with amounts above 100 baker's per cent, the gelatinization of the starch is delayed. This results in a weakening crumb elasticity which in turn leads to an impaired chewing impression (clumping, pasty) and non-complying taste (raw, doughy, or not completely baked). The actual starch gelatinization and swelling will take place during the baking process starting at an oven heat above 50 °C.
Because the sugar binds the water, the resistance of the beater in the batter also increases. Sugar is heavy and too many sugar crystals, with their sharp edges, destroy the foam and also aggravate the dispersion of air in the batter. This is the reason why the weight per liter and the torque are increasing.
The development time of the batter and the consistency maximum is found to increase in a non-uniform way.

Test series with pound cake batter

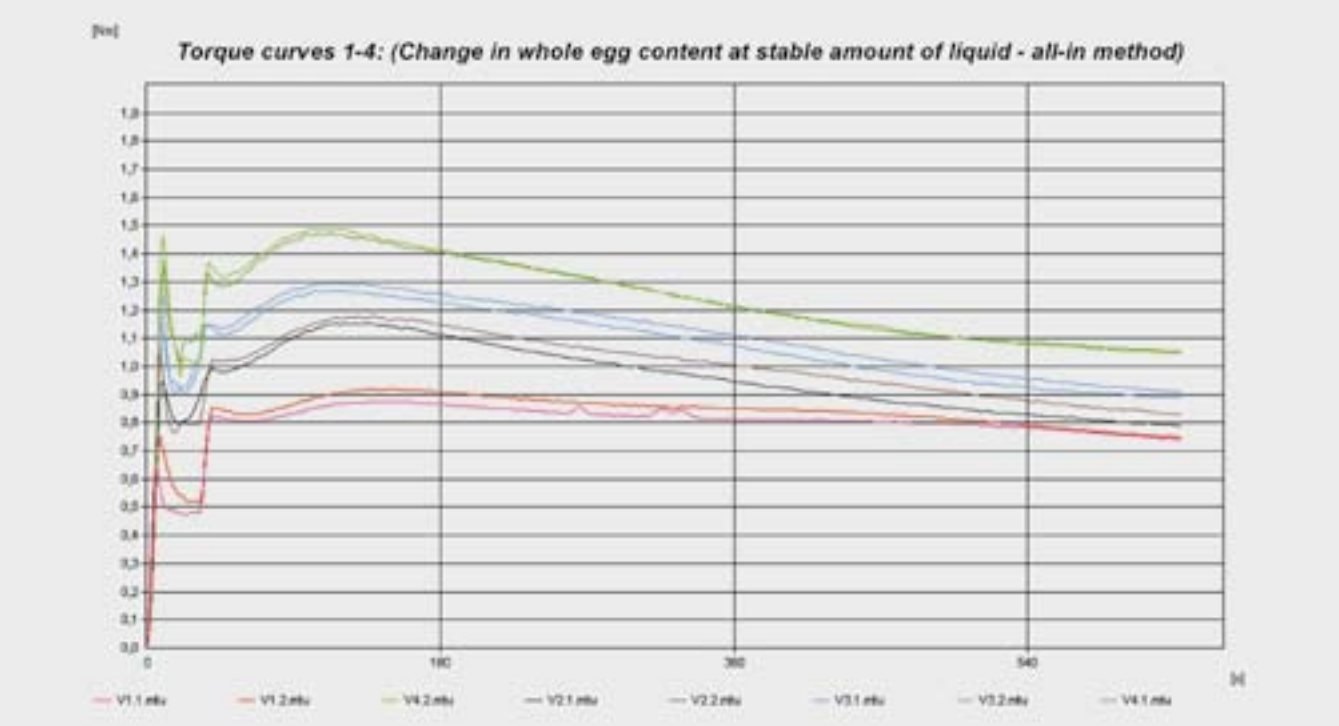
Here are the results for pound cake batters: Changes in whole egg content with stable amount of liquid (all-in method)

The following parts were used: test 1 – 40 parts (baker's per cent) whole egg, test 2 – 65 parts, test 3 – 80 parts, test 4 – 100 parts whole egg in the mass while the total weight of the batter was always the same.

The graph shows the torque curves: red lines of the first double test, brown lines of the second double test and blue lines of the third double test and the green lines of the fourth double test.

Table 6: Batter development time and consistency maximum 1-4 (Change in whole egg content at stable amount of liquid – all-in method)				
All-in method baking test no	**1**	**2**	**3**	**4**
Development time of the batter (s)	140	130	120	111
Consistency maximum (Nm)	0.9	1.15	1.25	1.45

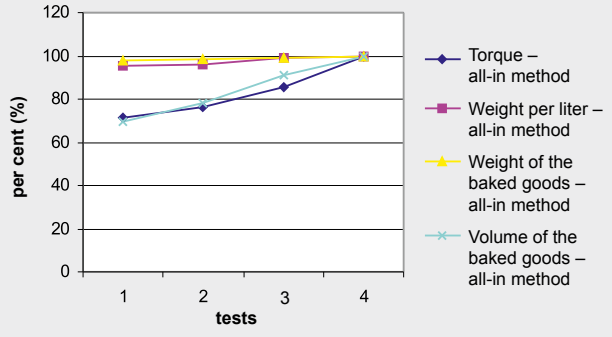
Table 7: Pound cake test 1-4 (Change in whole egg content at stable amount of liquid – all-in method)				
Baking test no	**1**	**2**	**3**	**4**
Torque at the time of batter removal (Nm) ≙ per cent (%)	0.75 ≙ 71.4	0.8 ≙ 76.2	0.9 ≙ 85.7	1.05 ≙ 100
Weight per liter (g/l) ≙ per cent (%)	905.5 ≙ 95.4	909.5 ≙ 95.8	938.5 ≙ 98.9	949 ≙ 100
Weight of baked goods (g) ≙ per cent (%)	355.7 ≙ 97.6	359.1 ≙ 98.5	361.8 ≙ 99.3	364.4 ≙ 100
Loss on baking (%)	11.6	10.2	9.6	8.9
Volume of baked goods (ml) ≙ per cent (%)	350 ≙ 69.3	395 ≙ 78.2	460 ≙ 91.1	505 ≙ 100
Volume yield (ml/100g batter)	87	99	115	127
Specific volume (ml/g baked goods)	0.97	1.1	1.28	1.39



From test to test, the consistency maximum increased by approximately 0.18 Nm. In this test series, the development time of the batter decreased by 10 s.

With higher whole egg contents, the torque and the volume of the baked goods increase to the same degree. The weight per liter and the weight of the baked goods remain almost unchanged.

Graphic depiction of torques, weights per liter, weight of baked goods and volume of baked goods in per cent of tests 1-4 (Change in whole egg content at stable amount of liquid – all-in method)



The height of the baked goods can be clearly seen in the pictures and with that the increase in volume and the improvements in shape and bloom.

With increasing whole egg content, the browning of the baked goods improves from weak to normal, the leavening changes from dense to medium, the pore pattern from closed to medium, the crumb properties from firm (gummy) to medium, the crumb color from off-color to yellowish, the sliceability from insufficient to good and the chewing properties and the taste from greasy and heavily impaired to medium and acceptable.

With increasing whole egg contents at constant amounts of liquid, the torque at the time of the removal of the batter, the weight per liter, the weight of the baked good and the volume of the baked good continuously increase.

Table 8: Sensory properties of pound cakes, test 1-4 (Change in whole egg content at stable amount of liquid – all-in method)

Baking test no	1	2	3	4
Shape/bloom	satisfactory (too small)	satisfactory (too small)	good	good
Browning	too weak	too weak	still weak	normal
Leavening	dense	dense	still dense	aerated
Pore distribution	uniform	uniform	uniform	uniform
Pore pattern	closed	closed	slightly closed	medium
Crumb characteristics	firm	firm	firm	medium
Color of the crumb	off-color	off-color	yellow	yellowish
Sliceability	insufficient	insufficient	satisfactory	good
Chewing properties	greasy	greasy	medium	medium
Taste/smell	heavily impaired	heavily impaired	impaired	perfect

During the whipping of egg foam, the proteins are mechanically denatured thus leading to an increase in foam viscosity.

The foam is more stable with higher egg contents. This means that the beater has to overcome a higher resistance and that the torque is increasing.+++

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