CONVERSION OF CONSTANT-FLOUR FARINOGRAPH ABSORPTION TO CONSTANT-DOUGH BASIS[1]

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ABSTRACT

The relation between the amount of water used in preparing farinograms by the constant-dough method (W_{CD}) and the water in the constant-flour method (W_{CF}) is formulated as

$$W_{CD} = W_{CF}\ (80/D_{CF}) + K\ (80 - D_{CF})$$

where D_{CF} denotes the dough weight in the constant-flour method, 80 is the dough weight in the constant-dough weight method (small bowl), and K is a constant. An identical equation may be written for the large bowl with 480 replacing 80 as the constant weight of dough.

The proportionality constant K was evaluated experimentally and was found to be 0.05. The same constant was found to apply for the large and the small bowl and for different classes of flour.

With this constant and equation, farinograph absorptions obtained by the constant-flour method can be readily converted to the constant-dough basis.

Cereal Laboratory Methods (1) describes two procedures for the use of the farinograph. In one method, a constant amount of flour is used with sufficient water to obtain a curve centered about the 500-unit line at its maximum; the weight of the dough in the mixing bowl varies from flour to flour. In the second method, the total weight of dough is kept constant, whereas the ratio of flour to water is varied. At 60% absorption and at 14% moisture the two methods coincide, but, at lower or higher absorptions, considerable differences between the two methods have been reported (2,3).

This paper presents data and discusses the conversion of farinograph absorption obtained by the constant-flour method to predict quantitatively the results on a constant-dough basis.

Basis of Relationship between the Two Methods. The relation between the amount of water used in the constant-dough method (W_{CD}) and the water in the constant-flour method (W_{CF}) may be formulated in mathematical language as follows:

$$W_{CD} = W_{CF}\ (80/D_{CF}) + K\ (80 - D_{CF}) \quad (1)$$

where D_{CF} denotes the dough weight in the constant-flour method, 80 is the dough weight in the constant-dough weight method (small bowl), and K is a constant. This means that the water used in the

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constant-dough method is equal to the water used in the constant-flour method, both calculated to the same basis of 80 g., plus a correction factor which depends on the difference in the amount of dough between the two methods.

An identical equation may be written for the large bowl with 480 replacing 80 as the constant weight of dough.

The proportionality factor K in the above equation can be readily evaluated experimentally. A series of precise data by the two methods on representative flours is necessary; the constant so obtained may then be used to translate data obtained by the constant-flour method to the constant-dough method basis.

Materials and Methods

In all, 64 flours were used in this study. These flours represented hard red spring (HRS), hard red winter (HRW), soft red winter (SRW), and soft white (SWW) wheats. Most flours were of American and some of Canadian origin. The farinograph absorptions ranged from approximately 50 to 70%.

The work was done in two laboratories using three farinographs, three small bowls, and three large bowls.

The constant-flour weight and the constant-dough weight methods were followed as outlined in *Cereal Laboratory Methods* (1). It was advantageous to record the results as the amount of water added to the flour instead of on the usual percentage basis. The percent-flour basis and the 14% moisture basis are best regarded as special cases of the more general treatment adopted here. A high degree of precision in the data was aimed at, especially where the differences between the two methods were small.

Results

Evaluation of the Proportionality Constant K. The first step in processing of the experimental results was to evaluate the constant K in equation 1. This was done by substituting experimental values for the water required by each method, together with appropriate dough-weight data in equation 1, and calculating K for each flour.

A careful study of the results led to the following conclusions. The same factor was obtained for each of the different classes of flour: hard red spring, hard winter, and soft. Moreover, the same factor was obtained for the small and the large bowl, provided that the data were expressed as water added to the flour used.

An over-all proportionality constant K of 0.05 was obtained from the mean data. What this constant means is that a bulk of each gram of dough above or below 80 or 480 g. has the same effect on the farinograph chart as 0.05 ml. water less or more, respectively. The precision of this value for K is illustrated in the next section by applying it to one set of data for the small bowl and to one set for the large bowl.

Comparison of Experimental and Predicted Values for the Constant-Dough Absorption. In order to illustrate the type of results that can be obtained with the proposed proportionality constant, as well as to indicate the precision of the results, selected data are summarized in Tables I and II. The data on the small bowl were obtained by the Grain Research Laboratory and those for the large bowl by General Mills' laboratory.

TABLE I

EXPERIMENTAL AND PREDICTED CONSTANT-DOUGH WEIGHT ABSORPTIONS IN TERMS OF WATER ADDED TO FLOUR USED – SMALL BOWL

Flour Type	Flour Moisture	Weight of Flour (14% m.b.)	W_{CF} Experimental	D_{CF}	W_{CD} Experimental	W_{CD} Predicted
	%	*g*	*ml*	*g*	*ml*	*ml*
HRS	11.8	48.75	35.60	84.35	33.50	33.54
HRS	13.8	49.90	33.70	83.60	32.05	32.07
HRS	13.4	49.65	33.40	83.05	32.00	32.02
HRS	12.8	49.30	33.30	82.60	32.05	32.12
HRS	13.2	49.55	31.95	81.50	31.25	31.28
HRS	14.0	50.00	31.70	81.70	30.95	30.96
HRW	13.5	49.70	31.55	81.25	31.05	31.00
HRW	13.3	49.60	31.10	80.70	30.70	30.80
SRW	11.0	48.30	28.55	76.85	29.90	29.88
SRW	11.7	48.70	27.80	76.50	29.30	29.24
SWW	12.8	49.30	26.25	75.55	28.00	28.02

TABLE II

EXPERIMENTAL AND PREDICTED CONSTANT-DOUGH WEIGHT ABSORPTIONS IN TERMS OF WATER ADDED TO FLOUR USED – LARGE BOWL

Flour Type	Flour Moisture	Weight of Flour (14% m.b.)	W_{CF} Experimental	D_{CF}	W_{CD} Experimental	W_{CD} Predicted
	%	*g*	*ml*	*g*	*ml*	*ml*
HRS	11.7	292.2	211.2	503.4	199.9	200.2
HRS	10.4	288.0	208.2	496.2	199.9	200.6
HRS	12.8	295.9	191.3	487.2	188.0	188.1
HRW	10.4	288.0	192.0	480.0	192.0	192.0
HRW	12.1	293.5	190.2	483.7	188.5	188.6
HRW	13.0	296.6	189.1	485.7	186.7	186.6
HRW	13.3	297.6	185.0	482.6	183.4	183.9
SRW	12.0	293.2	171.5	464.7	177.6	177.9
SRW	10.8	289.2	170.8	460.0	178.6	179.2
SRW	11.6	291.9	165.2	457.1	175.2	174.6
SWW	11.8	292.5	161.0	453.5	171.7	171.7

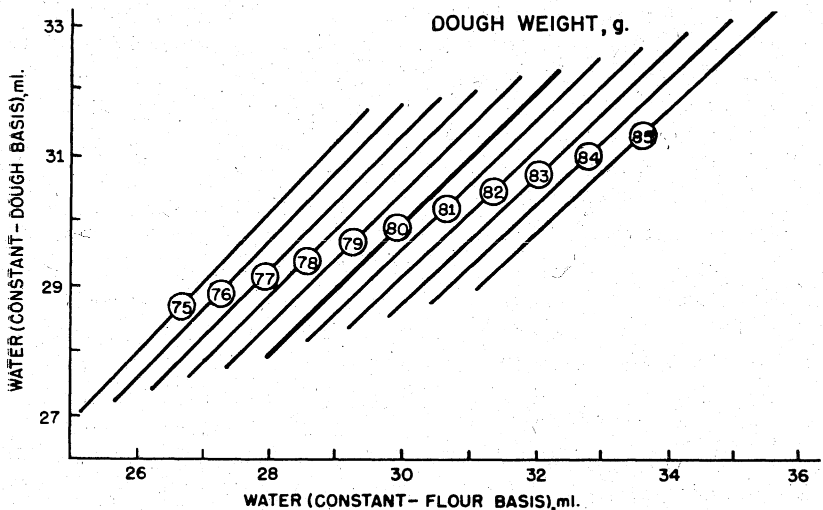

Fig. 1. A conversion graph to obtain constant-dough data from constant-flour farinograph data.

Table I summarizes the data for the small bowl. The first column shows the range of flours used in the study. The next four columns provide data on the amounts of flour, water, and the resulting dough in each instance. The last two columns show a comparison of the amount of water required in the test, determined experimentally with the calculated or the predicted value. The calculated values were obtained by substituting the appropriate values from the table into equation 1, using a value of 0.05 for the proportionality constant. Table II shows corresponding data for the large bowl.

A comparison of the experimental and predicted values for the constant-dough method shows a high order of precision. In the small-bowl data, the largest difference is 0.1 ml. water. In the large-bowl data, the largest difference is 0.7 ml. water. In terms of absorption percent, the mean data indicate the differences to be approximately 0.1%. If it is considered that both the constant-flour and constant-dough data contain an experimental error, it must be concluded that the value of K is highly satisfactory.

General Application of the Method of Conversion of Constant-Dough and Constant-Flour Farinograph Data. It is suggested that the method of conversion of constant-flour data to the constant-dough basis should be of value in three different areas. These will be noted briefly.

The titration method in the constant-flour procedure is somewhat simpler in the laboratory than the successive-approximation method in the constant-dough procedure. For this reason, the constant-flour procedure together with equation 1 may be used either as a preliminary step in the constant-dough procedure, or it may be used directly to predict the constant-dough data.

While the use of equation 1 is to be preferred, a table or a graph may be prepared. Figure 1 shows a graphic representation. It will be noted that a different line is necessary for each dough weight.

A second area in which the conversion of data from one basis to another should be of value is in comparison of data reported in the literature on the constant-flour basis with those reported on the constant-dough basis. From the percent absorption in the constant-flour method, the amount of water, weight of flour, and the weight of dough can be calculated readily, preceding the use of equation 1.

Finally, the original purpose of this investigation was to obtain a closer understanding of the fundamental relation between the constant-flour and constant-dough farinograph procedures. The data presented in this paper should contribute to a more thorough understanding and a better appreciation of the two procedures.

Literature Cited

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