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The baking value of meal, milled from wheat varieties grown in the Netherlands

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The Baking Value of meal, milled from wheat varieties grown in the Netherlands.

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Flour, milled from Dutch wheat, is not very suitable for making bread. For white bread imported wheat is chiefly used. For bread which is baked from wheat meal, however, home-grown wheat is used for the most part. Knowledge of the baking quality of the home-grown wheat varieties is therefore of interest in this connection. For this reason we presently study in our institute especially the baking value of wheat meal, though it may be remarked that comparative baking tests with flour have given good correlating results with the baking tests executed with wheat meal. So it is possible to get indications about the baking value of the flour by performing a baking test with meal and vice versa.

As we consider the baking test as the base of our research concerning the baking value something, in the first place, will be said about the way we perform this test. After this, the most important factors which influence the baking quality will be discussed on the basis of the results of the baking tests. Thereupon, something will be told about our experience with dough- and gluten testing methods. Finally, some

remarks will be made about observations regarding the influence of the activity of enzymes on the baking value.

The Baking Test.

The baking test is the only method where all factors being important for the process of bread-making tell to full advantage. Reliable results, however, are only obtained, if the method is fully standardised. In the baking test two factors are important: the length of the last fermentation period and the amount of water in the dough.

In our institute the length of the last fermentation period is the time required for the development of a certain volume of carbondioxyde by the dough. This is measured by means of the „S.I.A. Fermentation Recorder" in an aliquote part of the original dough. In baking tests with meal of home-grown wheat the standardised quantity of carbondioxyde is 300 ml per amount of dough corresponding to 400 grams of bread (about 240 gr of dry matter). The amount of water which is added to the meal in dough-making is regulated in such a way that initial consistency of the dough, as measured by the Brabender-farinograph, is 300 Brabender units. This year we also made baking tests where the consistency of the doughs after the last fermentation period (at the moment the dough will be put in the oven) has been standardised on 300 B.u. This last method has certain advantages, especially in those cases where the influence of bromate has to be studied, generally when stiffening-up of the dough takes place during the fermentation process. If sufficient water is used in the dough to compensate this stiffening-up, the possibility of getting maximal bread volumes is increased. The difference between these two methods is very obvious, e. g. in the case of the wheat variety *Alba,* where by standardising the consistency of the dough at the end of the fermentation period the resulting improvement of the loaf volume after the addition of bromate to the dough was the fourfold of the improvement after standardising the initial dough consistency.

Results of the Baking Tests.

The objects of our studies concerning the baking quality are as follows:

a. Differences between varieties.
b. Influence of environment in which the wheat is grown on the baking quality.
c. Variance in the level of the baking quality in successive years.

Conclusions about the influence of wheat variety and district of origin on the baking value must be based on the average results of the examination of several comparable samples, in order to preclude the effect of accidental factors. For our studies in the last two years the samples were chosen according to the following scheme:

Seven winter wheats and four summer wheats from crop 1950 were studied. From each of the seven winter wheats samples were collected from 13 trial fields, distributed over the four most important agricultural districts of the Netherlands. The summer wheats were collected in the same way from 9 trial fields. For each variety the samples coming from trial fields in the same agricultural district were mixed, so that finally we got 28 samples of winter wheat and 16 samples of summer wheat.

From crop 1951 baking tests were only made with samples of 3 varieties: Alba, Staring and Minister. These were collected from 15 trial fields. The 45 samples were examined separately. The experiments with samples of crop 1950 intended in the first place to gain information about the varietal differences, whereas the experiments with samples of crop 1951 intended to gain information about the environmental influences. The research concerning crop 1951 also included other varieties than the three mentioned above, but the baking quality of these varieties was only studied by means of indirect methods (Pelshenke test, Berliner test and alveograph).

Distinct differences between varieties have been established. It is an important fact that in relation to the baking

value the order of succession, found for the different varieties, is fairly the same in successive years. The *level* of the baking value, however, varies significantly in successive years.

It is stated (5) that a low crop often correlates with a high baking quality. In 1947 the yield was low in consequence of very high temperatures during the flowering of the wheat and in 1948 in consequence of abnormally heavy rains. In both years the baking quality of the wheat was relatively high. For the crop 1949 the weather was favourable for high yields, but the baking value of the wheat was low. In 1950 neither yield nor baking value was exceptional. The baking value of the wheat from crop 1951 was comparative with the low baking value of crop 1949. The yield in 1951 was higher than in 1950, though not as high as in 1949. Possibly the frequent occurrence of sprouting has also contributed to the low baking quality of crop 1951.

The following table gives the baking value of the varieties of crop 1950 examined, with and without addition of bromate to the dough.

Table 1.

The baking value of wheat varieties

Crop 1950.

The value 2 indicates a loaf volume of ± 3000 ml/kg of flour, the value 8 a loaf volume of ± 3800 ml/kg of flour.

	Variety	*Baking value*	
		without $KBrO_3$	with 100 p.p.m. $KBrO_3$
Winter Wheats	Alba	6	8
	Cappelle	6	8
	Juliana	4	7
	Minister	3	7
	Heine VII	3	7
	Staring	3	5
	Carsten V	2	3
Summer Wheats	Koga	6	6
	Hera	5	7
	Blanka	4	6
	Peko	4	6

aking value is expressed in figures from 2 to 8, e of loaf volume. The value 2 indicates a loaf volume

of about 3000 ml/kg of flour, the value 8 a loaf volume of about 3800 ml/kg of flour.

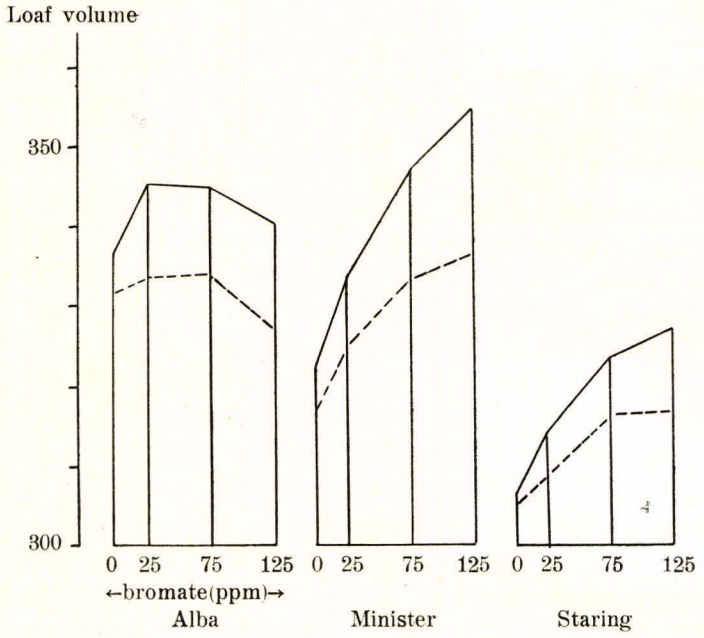

Figure 1.

The influence of bromate on loaf volume.

Crop 1951.

Comparison of three wheat varieties.

Figure 1 shows the average results of baking tests with samples from three varieties, Alba, Minister and Staring, with varying additions of bromate to the dough. The quantities of bromate added are 0, 25, 75 and 125 parts per million, calculated on the basis of flour. The dotted lines indicate the loaf volumes which resulted if the initial consistency of the dough was standardised, while the drawn lines indicate the volumes resulting if the consistency after the last fermentation period was standardised.

In the case of Alba practically no improvement resulted after the addition of bromate if the initial consistency was standardised. The highest dose of bromate even caused a decrease of loaf volume. When the consistency after the last

fermentation period was standardised, a distinct improvement resulted after the addition of 25 p.p.m. of bromate. Higher quantities of bromate gave less improvement, but the volumes were still higher than without bromate addition.

The differences between the three varieties, as shown in figure 1 are evident. Without bromate addition the variety Alba shows the highest loaf volume. The baking quality of Minister, however, is so much improved by the addition of high quantities of bromate, that after the addition of 75 and 125 p.p.m. of bromate higher loaf volumes resulted with Minister than with Alba. In the case of Minister probably the optimal loaf volume has not even been reached.

Alba, which is the most grown wheat variety, also has the highest baking value. It is interesting to notice, however, that the protein content of this wheat variety is very low. The protein and the gluten contents are in general poor criterions for the baking value. Another example is Carsten's V, which has a very low baking value and a relatively high protein content.

The addition of bromate nearly always gives a significant improvement of the baking value.

The order of succession of the varieties is about the same with and without the addition of bromate, but the variant differences are smaller after the addition of bromate. Possibly this is partly due to the fact that in the experiments with samples of crop 1950 the method of standardizing the initial dough consistency has been used, and it might be that when using the new method of standardising the dough consistency after the fermentation process the varieties with high baking value will be improved more by adding bromate than has been found now.

However, with samples of crop 1951 the new method has also been used and then still typical varietal differences appeared as to the response to bromate.

Remarkable is also the behaviour of Koga. This is the best summer wheat with respect to baking value, when no bromate is added, but probably in consequence of the rather stiff gluten there is practically no improvement after the addition of bromate.

Besides the differences between varieties the environment in which the wheat is grown has a great influence on the baking value. When it is said, that Alba is of a higher baking quality than Staring, this is only true for the average baking value, or if samples of these two varieties are compared, which have been grown under the same circumstances. For samples from different districts, however, the reverse may be true.

Undoubtedly, the significant differences which were found by comparing different trial fields, are partly due to different weather conditions. How far specific soil properties and the way of dunging are important, we hope to find out in future experiments. If, by special dunging methods, the baking value can be improved, this would make it possible to increase the level of the baking value of wheat as a whole.

Indirect methods.

Although the baking test approaches at the nearest the practice of bread making, it is too elaborate and too expensive for examining samples on a large scale. It is therefore desirable to use simpler methods, which are also able to give information about the baking value.

One of these methods is the alveographic method according to CHOPIN.

We found for the W-value a fairly good correlation with the bread volume. An exception is the variety Koga. According to the alveograms one would expect that the variety would be comparable with an American hard wheat of moderate baking value. Nevertheless, in the baking test it gives no better results than other home-grown wheats of good quality.

With the alveograph it is possible to study many samples in a relatively short time, but flour must be used for the experiments, and samples of 250 grams are necessary. For instance, in most cases of samples from wheat breeders this quantity is still too large. A well known method, requiring only small samples, is the Pelshenke- test. According to PELSHENKE (1) a small dough ball made from meal, yeast and water, is placed in distilled water. The developed car-

bondioxyde causes an increase in the volume of the ball and at last it disintegrates. The length of time elapsed before this disintegration is the Pelshenke-index (P) which is used as a criterion for the baking value.

Several modifications of this method are used. MAES (2) measures besides the P-value the total volume of the carbondioxyde at the moment of disintegration. As the P-value is dependent not only on the quality of the gluten, but also on the rate of production of the carbondioxyde (yeast quality), this modification enables to correct the P-value.

In our institute we developed a method to measure the

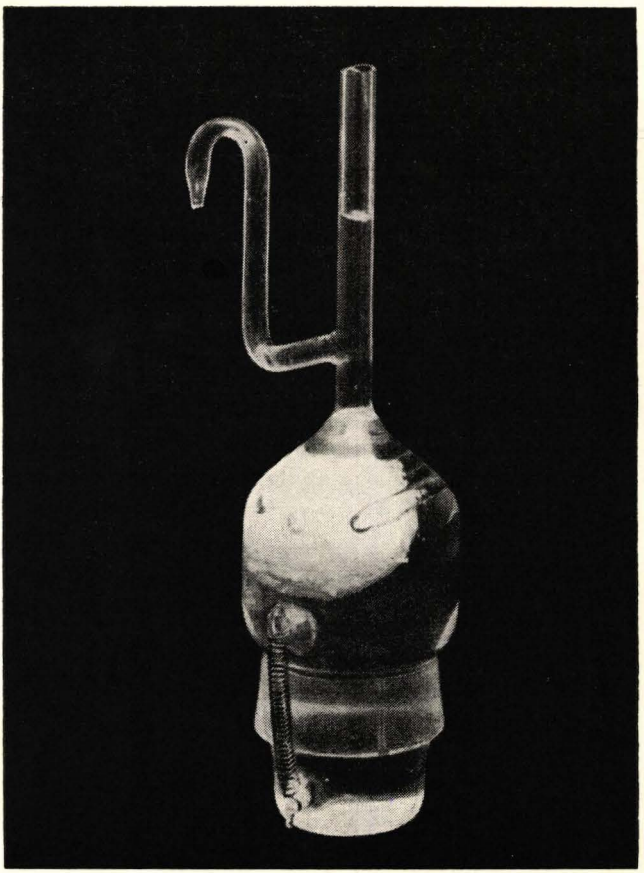

Figure 2.
Apparatus for measuring the increase of dough ball volume (V).

maximum increase of the dough ball volume (V) which is indepent of the rate of carbondioxyde production. The part of the gas which is not retained by the dough, is allowed to escape. The quantity of the water which is pushed away by the swelling of the dough ball is collected and measured by weight or volume (Fig. 2).

In 1951 MILLER, EDGAR and WHITESIDE (3) described a method which is based on a comparable principle.

Recently we found out that GLIEMEROTH (4) has published a similar method as early as 1935. Our method was tested by comparing the P- and V-values, as measured in our apparatus, with the results of the baking tests. In the first place it was stated that more reliable results are obtained, when the dough is given a resting period, before it is made into a ball. For practical reasons we chose a rest of two hours. Concerning the samples from crop 1950 we can only give the results, based on the P-values, as the method of measuring V was not yet fully developed. The average P-values and the average loaf volumes showed a good correlation for the examined varieties (correlation coefficient 0,88). While the loaf volume not only showed varietal, but also significant environmental differences, the P-value showed no significant environmental differences.

For the samples of crop 1951 both the V and the P-values were measured. As mentioned before, the 45 samples from this crop year were from the 3 wheat varieties Alba, Minister and Staring and originated from 15 trial fields. Environmental differences are most obvious, when each of the 3 magnitudes P, V and loaf volume, found for the 3 varieties from each trial field, are averaged.

The following correlation coefficients were calculated for these average values:

loaf volume — P : 0,28
loaf volume — V : 0,81

For the 45 separate samples these correlation coefficients were:

loaf volume — P : 0,444
loaf volume — V : 0,666

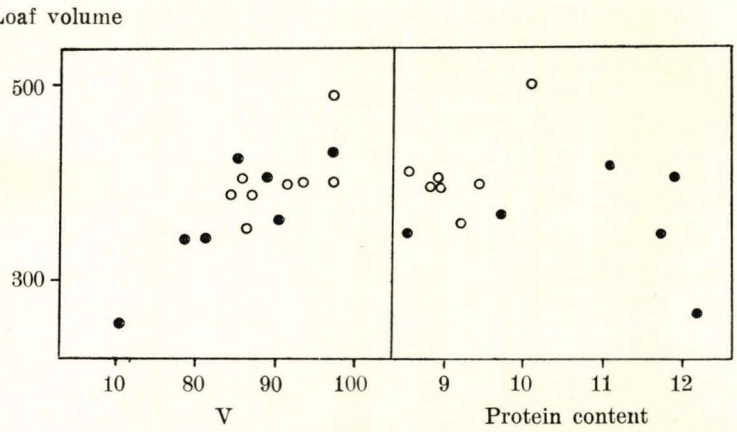

Figure 3.

Correlation of loaf volume with V-value and protein content.
Crop 1951.

● = heavily sprouted
o = less sprouted.

In figure 3 the average loaf volumes for the 15 trialfields have been plotted respectively against the V-values, as measured in the apparatus, shown in figure 2 and the protein content, determined after Kjeldahl.

Another method for testing small samples is the Berliner-swelling test. This method was used by us for the first time for the study of crop 1951. In its modern form this method consists of taking 0,5 grams of washed-out gluten and dividing it into 15 parts, which are immersed in a 0,02 N solution of lactic acid, after which the vessel is placed in a rotating thermostate and kept for half an hour at 27° C. The grade of turbidity of the liquid, which is determined by means of an electrophotometer, is used as a criterion for the baking value. We found that each of the two methods, the Pelshenke and the Berliner test, correlates with the baking test. Their mutual correlation, however, was found to be lower, which means that in a certain sense their results are complementary to one another.

On the basis of this experience we recently examined about 250 samples of wheat ,from wheat breeders, on their baking value by applying both testing methods.

The activity of enzymes.

Another important subject in studying the baking value is concerned with the influence of enzymic activity on the quality of the bread. The wheat samples from crop 1951 were all more or less sprouted, which in the baking test resulted in a sticky crumb. The grade of stickiness was determined by us by hand and with the „panimeter". The panimeter is an apparatus which has been developed in our institute.

It is shown in figure 4

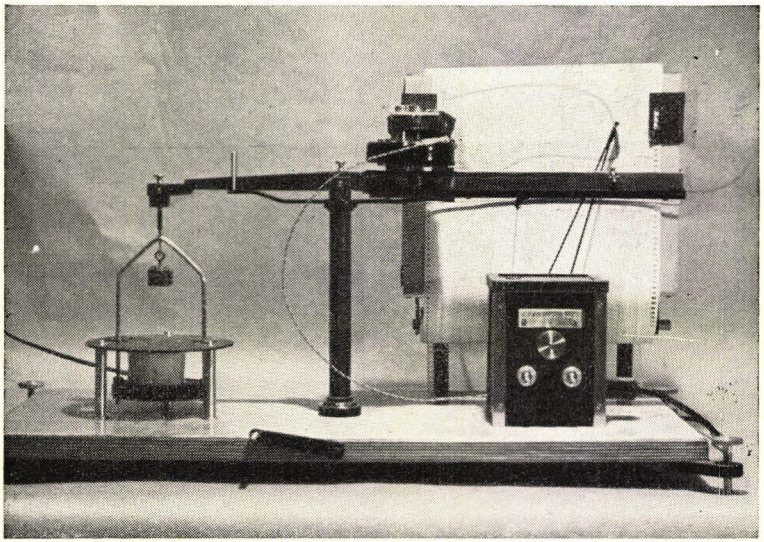

Figure 4.

Panimeter.

A piece of bread is pressed against a fixed metal plate by means of a movable plate by an increasing force. This gradually increasing force is obtained by a motor, which moves along the arm of a level. The compression of the crumb is graphically recorded and this compressibility yields a criterion for the softness. When the motor has reached the end of the arm of the level, it is allowed to move in the opposite direction. By doing this, the compressing force gradually decreases and the rebound of the crumb is recorded.

The rebound is negatively correlated with the stickiness as determined by hand (correlation coefficient: 0,83).

Stickiness of the crumb is caused by the degradation of starch, as a result of alpha-amylase activity, which can be determined with the amylograph by measuring the viscosity of a flour-water suspension as the temperature is gradually increased. The maximum viscosity in the amylogram was highly correlated with the stickiness of the crumb (correlation coefficient: 0,87).

The maltose figure, though primarily being a measure of the betha amylase-activity, also proved to be a very good criterion for the stickiness of the crumb (correlation coefficient: 0,89). The maltose figures of the samples from crop 1951 ranged from 1,15 to 5.0. Pronounced stickiness was found when the maltose figure was higher than about 2.

In figure 5 the average maltose figures and the average viscosity values for the 15 trialfields are plotted against the corresponding values for the stickiness of the crumb, as measured by hand and by panimeter.

In 1950, when sprouting practically did not occur, the level of the maltose figures was considerably lower. The maltose figures then ranged from 0,60 to 1,30. Probably also the low loaf volumes in 1951 were partly due to the frequent occurrence of sprouting. Likewise, it is obvious that in 1951 the same factor also contributed to the environmental influences on the loaf volume. The average loaf volumes, calculated for the trial fields, showed a distinct negative correlation with the average maltose figures (correlation coefficient: 0,57). There were no distinct varietal differences between the maltose figures. Concerning the proteolytic activity it is remarkable that no distinct correlation was found with the loaf volume (correlation coefficient: 0,14).

SUMMARY

In performing the baking test, it was evident that standardising the consistency of the doughs *after* the last

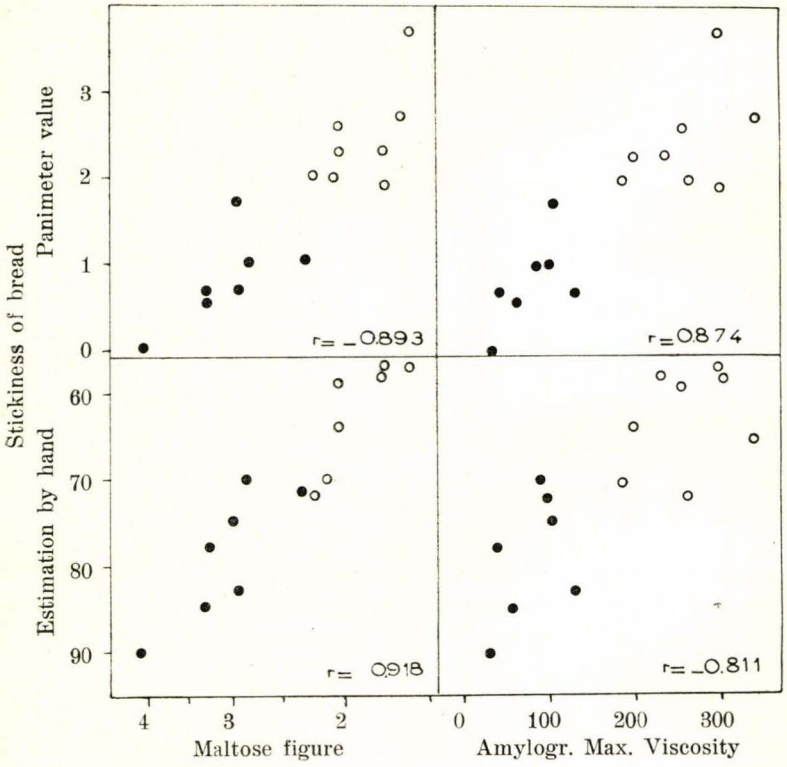

Figure 5.

Correlation of maltose figure and maximum viscosity (Brabender amylograph) with the stickiness of the crumb.

r = correlation coefficient
• = heavily sprouted
o = less sprouted.

fermentation period has certain advantages to standardising the consistency of the doughs *at the beginning* of the fermentation process.

Distinct varietal differences have been established. The order of succession of varieties on the basis of baking quality has been found to be about the same in successive years.

Environmental differences are partly due to local weather conditions. Factors which are favourable for high crop yields often cause lower gluten quality and quantity. Sprouting of the wheat is attended with stickiness of the crumb and is also noticeable in the decrease of the loaf

volume. Possibly soil and dunging also contribute to the established environmental influences on the baking quality.

The addition of bromate to the dough generally improves the baking results significantly. Typical varietal differences in the response to bromate have been stated.

The Pelshenke test and the Berliner test were found to be useful methods for the examination of the baking quality of small samples.

In the case of crop 1951 reliable indications were obtained by means of the amylogram and the maltose figures for stickiness of the crumb, as caused by sprouting of the wheat.

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