# NOTES ON FLOUR-STRENGTH.

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THE term "strength" as applied to flour refers to that combination of qualities which makes a flour valuable for baking purposes. The problem as to what exactly constitutes flour-strength and whether it is possible to devise some ready means of determining this property without having recourse to the always rather unsatisfactory baking test, is one that has engaged the attention of many workers in different parts of the world for some time and still remains unsolved.

In order to place the problem on a satisfactory basis, the British Home-grown Wheat Committee has arrived at the following definition of flour-strength as "The capacity to make a big well-piled loaf."[1] Prof. Wood[2] further points out that this is a complex of at least two factors, size and shape of loaf. The definition thus stated appears to include all the qualities the presence of which render a flour of good baking quality and to provide a clear statement of the problem presented to us.

It does not, as will be seen, include the power of producing weight of loaf. This property depends upon the power of the flour to absorb water, and although this does not perhaps strictly fall under the definition of strength, we have nevertheless satisfied ourselves that it is a measure of this quality and that those flours which absorb the larger

[1] A. E. Humphries, "The Improvement of English Wheat," Liverpool, 1905, also Humphries and Biffen, Journal Agric. Science, Vol. II, part i., page 1.

[2] T. B. Wood, "The Chemistry of Strength of Wheat Flour," Journ. Agric. Science, Vol II, part ii, page 139.

quantities to produce a dough of a given consistency are invariably those which produce a large well-piled loaf. In using the term "invariably," we mean only to imply that in our own experience flours with high water absorbing power are strong flours. All the new strong-flour varieties of wheat created by the late Mr. Farrer and those which Mr. Sutton his successor, is making, have been chosen on account of their high water absorbing capacity. In other words, while this function is not perhaps a necessary condition of strength it is nevertheless a fairly trustworthy guide, and the water absorbing power of a flour can be regarded as a measure of its strength in much the same way as the amount of carbonic acid in the air of inhabited rooms is a measure of the vitiation of such air.

It has the additional advantage of being a test which is readily applied and capable of fairly accurate determination which cannot be said of the baker's judgment. The art of baking depends so much on the skill of the individual that it is a very difficult thing to get two bakers to agree as to the baking quality of a flour to which they are unaccustomed, and still more difficult to obtain fixed data for the factors, size and shape, upon which accurate comparisons may be based. We consider therefore that it is of importance to determine the causes of the greater power possessed by certain flours of absorbing water, and the following notes embody the results of a few preliminary experiments in this direction, which though not conclusive may nevertheless throw some additional light on the subject.

**1. Note on the water absorbing power of different grades of flour.**—A sample of coarse middlings as produced by one of the leading millers in Sydney, was taken for the experiment. This product had a water absorbing power of 45·5 quarts per 200 lbs. sack and contained 9·66% gluten. The gluten was yellow, coherent and elastic.

In washing out the dough to obtain the gluten, impurities were noticeable, and it would seem that the usual time (one hour) for standing in dough before washing out is insufficient in the case of coarse products, as the dough during the washing out felt gritty. These middlings were then sifted in order to separate them into finer and coarser grades.

The first portion was retained by a No. 11 dressing silk (112 meshes to the linear inch) and passed through a No. 9 dressing silk (94 meshes to the inch). The second portion was retained by the No. 9 silk and passed through a No. 7 silk (80 meshes to the linear inch). The third portion was that which was retained by the No. 7 silk and passed through a No. 5 silk (64 meshes to the inch). We thus obtained from the original coarse semolina four different grades of varying fineness of division. These behaved towards water as shown in the following table:—

| | Water absorption quarts per 200 lbs. | Gluten. |
|---|---|---|
| Original coarse semolina ... ... | 45·5 | 9·66 |
| A. Portion passing through No. 5 but not through No. 7. | 44·0 | 9·78 |
| B. Portion passing through No. 7 but not through No. 9. | 46·6 | 10·07 |
| C. Portion passing through No. 9 but not through No. 11. | 47·0 | |

The finer portion of the semolina had a higher water absorbing power than the coarser, and the original semolina stands about half way between the finer and coarser portions in this respect. The actual proportions of fine and coarse particles were not determined, so that the exact average could not be calculated.

The effect of fineness of division upon the water absorbing power was even more apparent when the above products were reduced to flour. Each of the portions A, B, and C, and the original coarse semolina was put through the smooth rolls separately and reduced to flour until it passed through a No. 14 dressing silk (136 meshes to the linear inch). The result was as follows :—

| | Water absorption, quarts per 200 lbs. | Gluten. |
|---|---|---|
| Original coarse semolina reduced and dressed through No. 14. | 47·2 | 9·34 |
| Portion A (passed through No. 5) reduced and dressed through No. 14. | 47·0 | 9·32 |
| Portion B (passed through No. 7) reduced and dressed through No. 14. | 47·4 | 9·50 |
| Portion C (passed through No. 9) reduced and dressed through No. 14. | 47·9 | |

In the case of portion C. a very small proportion (amounting to ·08% of the whole) could not be got to pass through the No. 14 dressing silk. In other cases the whole was reduced to flour, dressing through No. 14.

It will be seen that here again fineness of division has increased the water absorbing power of the flour, but the peculiarity is noticed that although all the portions examined in the last table were practically of the same fineness, the water absorbing powers were not identical, as might have been expected, but varied with the water absorptive power of the stock from which they were derived.

The above experiments were repeated with a sample of middlings obtained in the Departmental mill from a sample of Fife wheat (a strong flour wheat), the semolina used in the previous experiments being obtained from a soft wheat. The Fife wheat semolina was first separated into three grades.

| | Water absorption, quarts per 200 lbs. | Gluten. |
|---|---|---|
| A. Portion passing through No. 5 but not through No. 7. | 48·9 | 12·06 |
| B. Portion passing through No. 7 but not through No. 9. | 49·3 | 12·21 |
| C. Portion passing through No. 9 but not through No. 11. | 50·8 | 11·74 |

On reducing these several products separately to flour, and dressing through a No. 14 silk, the following results were obtained:—

| | Water absorption, quarts per 200 lbs. | Gluten. |
|---|---|---|
| Portion A (passed through No. 5) reduced and dressed through No. 14. | 51·7 | 11·63 |
| Portion B (passed through No. 7) reduced and dressed through No. 14. | 52·0 | 11·48 |
| Portion C (passed through No. 9) reduced and dressed through No. 14. | 55·0 | 11·77 |

In this case the peculiarity noticed in the previous experiment is even more strikingly exemplified. If the water absorbing powers of the different grades of semolina are alone considered, it would appear that fineness of division is the determining factor, but on reducing these different grades to flour of a uniform grade the rather curious fact is to be noted that although further reduction in the size of the particles increases the water absorbing power, the flour derived from the finer and more absorptive grades of middlings is more water-absorptive than that obtained from the coarser grades.

In the case of the soft wheat this is not very striking, but in the case of the Fife wheat the gradation is quite strongly marked. The cause of this is so far unexplained.

**2. The effect of blending different wheats on the water absorbing power of the resulting flour.**—Two wheat mixtures were taken, one a mixture of the following soft wheats, Hudson's Early Purple Straw, Steinwedel and Federation, the other a strong-flour wheat mixture of Manitoba, Bobs and Comeback. These wheats when reduced had the following water absorbing powers and gluten contents.

| | Water absorption, quarts per 200 lbs. | Gluten. |
|---|---|---|
| Sample A (soft grain) ... ... | 45·0 | 8·2 |
| Sample B (hard grain) ... ... | 50·8 | 13·8 |

These wheats were blended in three different proportions and the blends milled separately, when the following results were obtained:—

| | Water absorption, quarts per 200 lbs. | Calculated. | Gluten. |
|---|---|---|---|
| Original Sample A (soft) ... | 45·0 | ... | 8·2 |
| Original Sample B (hard) ... | 50·8 | ... | 13·4 |
| Blend 1 (¾ A and ¼ B) ... | 46·2 | (46·7) | 9·55 |
| Blend 2 (½ A and ½ B) ... | 49·1 | (47·9) | 11·55 |
| Blend 3 (¼ A and ¾ B) ... | 50·8 | (49·2) | 11·9 |

It is to be noticed that the water absorbing power of the blend is on the whole somewhat higher than that calculated and in this case the most favourable blend appears to be an equal mixture of the two. The blend formed by mixing ¾ of the strong-flour wheats with ¼ of weak-flour wheats has exactly the same water absorbing power as the original strong flour wheat.

**3. Effect of mixing different grades of flour upon the water absorbing power of the resulting blend.**—Two samples of flour, one a fairly strong and the other a rather weak flour, were taken in order to ascertain what effect blending would have upon their water absorbing power.

The weak flour A had a water absorbing capacity of 48·9 quarts per 200 lbs. flour, the strong flour B a water absorbing capacity of 52·6. They were blended together in different proportions, the blending being done by thoroughly mixing them in a flour-sifter provided with revolving arms, and repeatedly passing them through a dressing silk (No. 14) 136 meshes to the linear inch. The following table gives the rather peculiar result:—

| | Water absorption, quarts per 200 lbs. | Duplicate. | Calculated. |
|---|---|---|---|
| Original sample A (weak flour) | 48·9 | ... | ... |
| Original sample B (strong flour) | 52·6 | ... | ... |
| Blend No. 1 (¾ A and ¼ B) | 51·0 | 50·0 | (49·7) |
| Blend No. 2 (½ A and ½ B) | 51·7 | 52·0 | (50·7) |
| Blend No. 3 (¼ A and ¾ B) | 53·6 | 53·7 | (51·6) |

This experiment was repeated with the two flours obtained in the previous wheat blending experiment:—

| | Water absorption, quarts per 200 lbs. | Calculated, | Gluten. |
|---|---|---|---|
| Original sample A (weak flour) | 45·0 | ... | 8·2 |
| Original sample B (strong flour) | 50·8 | ... | 13·4 |
| Blend No. 1 ($\frac{3}{4}$ A and $\frac{1}{4}$ B) | 46·5 | (46·7) | 9·6 |
| Blend No. 2 ($\frac{1}{2}$ A and $\frac{1}{2}$ B) | 48·9 | (47·9) | 11·4 |
| Blend No. 3 ($\frac{1}{4}$ A and $\frac{3}{4}$ B) | 51·8 | (49·2) | 12·1 |

The last experiment was repeated on flour obtained by milling single varieties of wheat in order to avoid using a blend of different wheats which has been shown to affect the water-absorbing power of the resulting flour.

The wheats taken were A a sample of Velvet Ear from New Zealand, a weak-flour wheat deficient in gluten, and B a sample of Comeback, one of Mr. Farrer's strong-flour creations. These wheats were converted separately to flour and gave the following results on blending:—

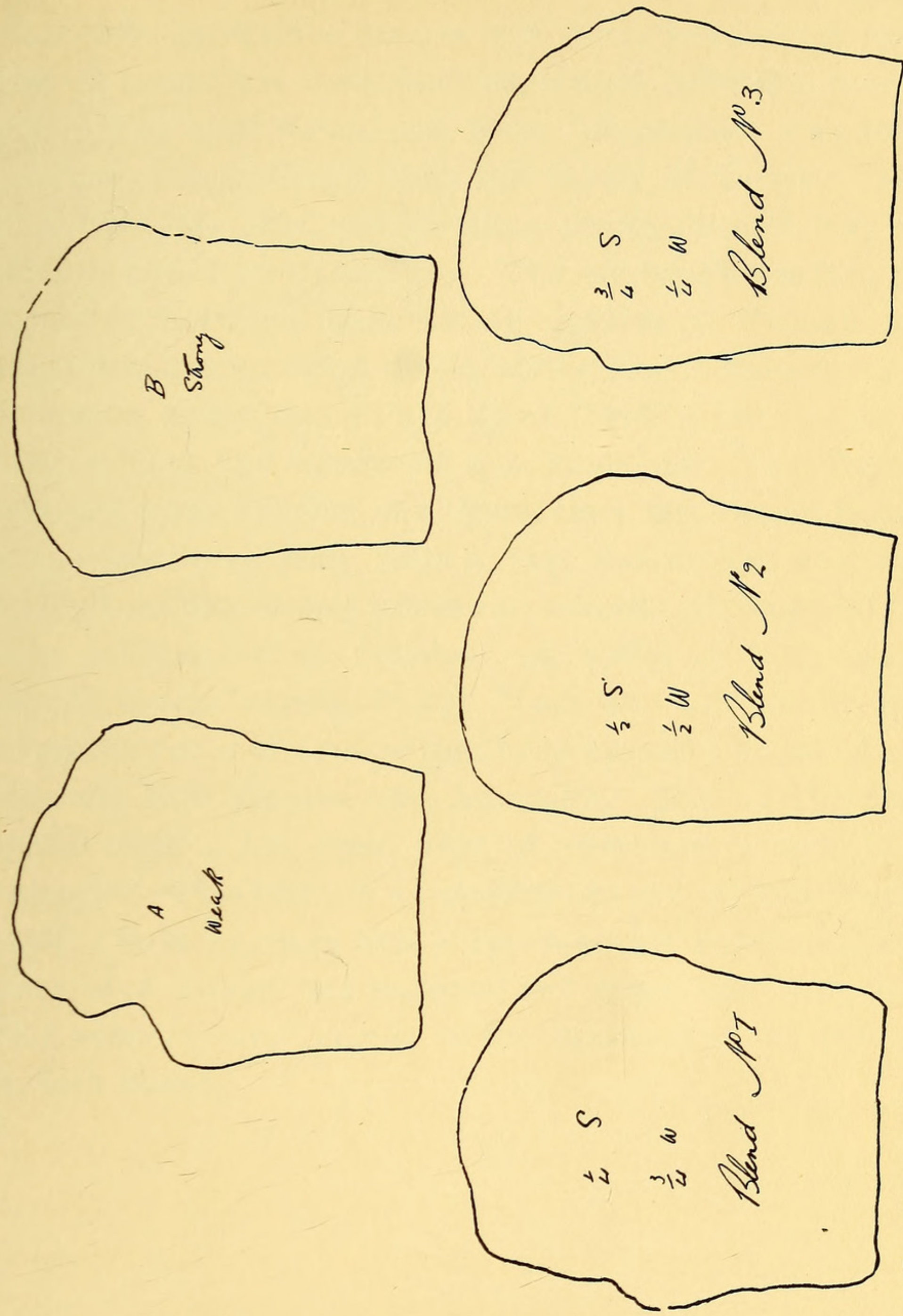
| | Water absorption quarts per 200 lbs. sack. | Calculated. |
|---|---|---|
| A (Velvet Ear) ... ... ... | 48·0 | |
| B (Comeback) ... ... ... | 53·6 | |
| Blend No. 1 ($\frac{3}{4}$ A and $\frac{1}{4}$ B) ... | 50·2 | 49·4 |
| Blend No. 2 ($\frac{1}{2}$ A and $\frac{1}{2}$ B) ... | 51·8 | 50·8 |
| Blend No. 3 ($\frac{1}{4}$ A and $\frac{3}{4}$ B) ... | 53·6 | 52·2 |

In all these cases the water absorbing power of the blend of $\frac{3}{4}$ strong and $\frac{1}{4}$ weak flour was not only considerably higher than the calculated, but as high as or even distinctly higher than that of the original strong flour. The strong flours had a slightly yellowish tinge and the weak flours more nearly white. The increase of yellow in the blend both of wheat and flour increased apparently regularly with the increased proportion of strong flour, but the peculiarity was noticed that the flour blends were of a better colour than the wheat blends, even when the flours were produced in the Departmental mill. It would therefore appear more profitable to the baker to blend his flours than to use flour of one quality from a mixture of wheats, and that the addition of a small proportion of weak flour to his strong flour, so far from reducing the water absorbing power of the latter, actually increases it.

In order to judge of the relative baking nature of these flours and blends the flours obtained in the last experiment were baked into small loaves (160 grammes flour being taken in each instance) and the volume of each loaf calculated from its displacement of wheat. This amount is given in cubic centimetres:—

| Loaf from 160 grammes. | Volume. |
|---|---|
| A (Velvet Ear) ... ... ... | 542·6 cubic centimetres |
| B (Comeback) ... ... ... | 579·3 ,, |
| Blend No. 1 ($\frac{3}{4}$ A and $\frac{1}{4}$ B) ... | 552·7 ,, |
| Blend No. 2 ($\frac{1}{2}$ A and $\frac{1}{2}$ B) ... | 558·7 ,, |
| Blend No. 3 ($\frac{1}{4}$ A and $\frac{3}{4}$ B) ... | 583·0 ,, |

Not only were the volumes of the strong-flour loaves larger, but the admixture of a small proportion of the weak flour gave a loaf of larger volume than was obtained from the strong-flour used alone. The loaves from B and from blend No. 3 were beautifully even in texture and in shape, the loaves from the weak flour and from the blends in which weak flour predominated being of inferior texture and exceedingly irregular in shape, which latter peculiarity may be seen from the attached outlines which represent the contour of the loaves cut through the centre.




Outlines of loaves obtained in the baking tests. The loaves have been cut through the centres, figures are one-fourth actual size.