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Bulletin No. [illegible]

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SOME TESTS

OF

FLOUR MADE FROM EGYPTIAN WHEATS.

BY

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MINISTRY OF AGRICULTURE, EGYPT.

TECHNICAL AND SCIENTIFIC SERVICE.

Bulletin No. 10.

(CHEMICAL SECTION.)

SOME TESTS

OF

FLOUR MADE FROM EGYPTIAN WHEATS,

BY

FRANK HUGHES, F.C.S.,

Membre de l'Institut Egyptien; Chemist, Ministry of Agriculture.

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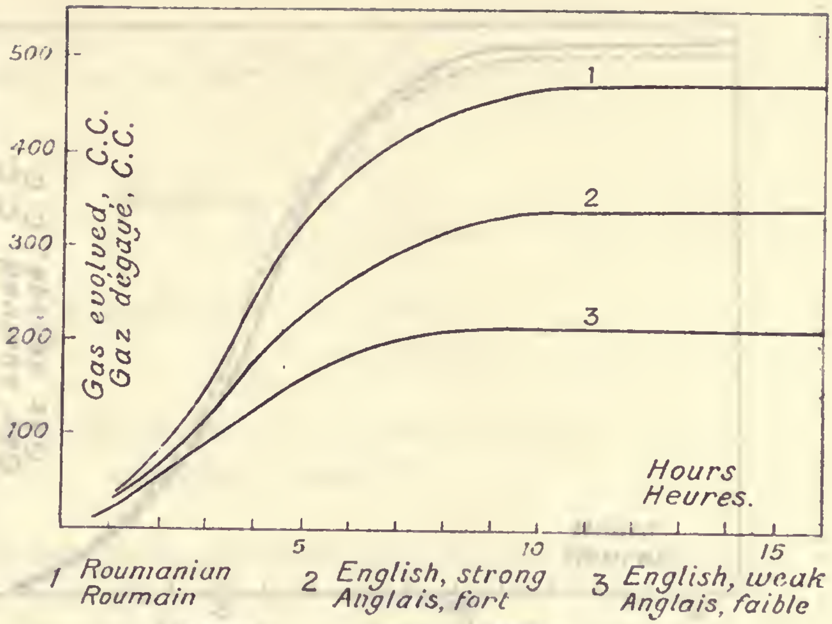


Fig. 1

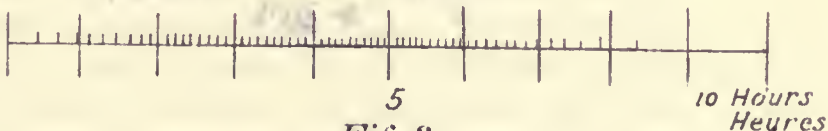


Fig. 2

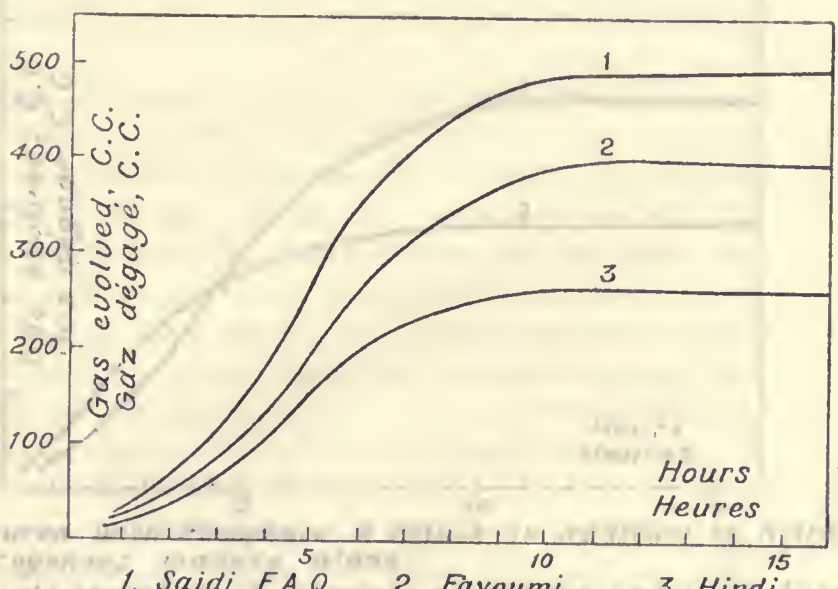


Fig. 3

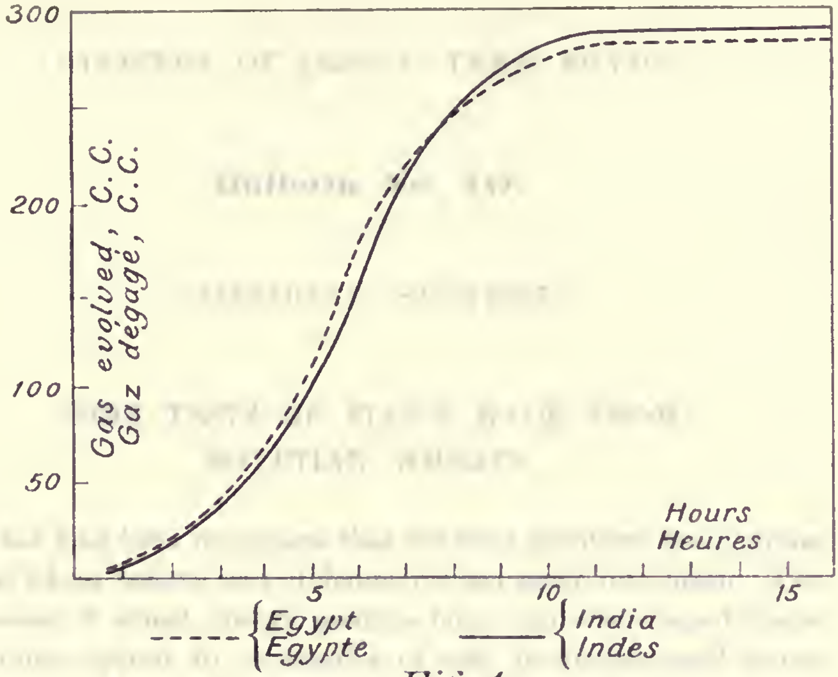
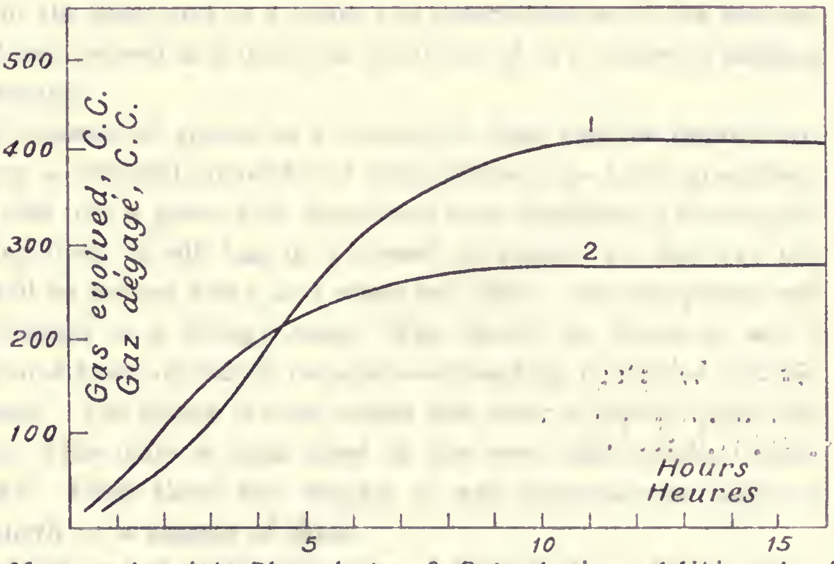


Fig. 4



1. Manured with Phosphate & Potash in addition to Nitrogen.
2. Nitrogenous manure alone.

1. Fumé avec du phosphate & engrais potassique en plus de l'engrais aroté
2. Engrais aroté seulement.

Fig. 5

produced by the Survey Dept. Egypt, 1916. (66. A)

MINISTRY OF AGRICULTURE, EGYPT.

Bulletin No. 10.

(CHEMICAL SECTION.)

SOME TESTS OF FLOUR MADE FROM EGYPTIAN WHEATS.

It has long been recognized that the flour produced from various kinds of wheat behave very differently when made into bread. Certain classes of wheat always produce large and well shaped loaves while others appear to be capable of only producing small loaves, and these frequently of an unsatisfactory shape. The former were known as "strong" flours or wheats and the latter as "weak" varieties. For some time the strength of a flour was thought to be in great measure dependent on the amount of nitrogenous material present in the flour, and as a result the determination of the amount of the gluten present in a flour was made use of as a means of judging of its strength.

The amount of gluten in a sample of flour may be determined by taking a weighed quantity of flour (twenty to forty grammes), making this into a paste with water and then kneading it thoroughly in a small linen or silk bag in a stream of water. In this way the starch will be carried away, and when but little is left the gluten will remain behind as a stringy mass. This should be tested to see if more than a trace of starch remains and washing continued till this is the case. The gluten is then wiped free from adhering water and weighed. This mass is then dried in the oven and weighed again when dry. From these two weights it was customary to judge of the strength of a sample of flour.

In a paper on the "Improvement of English Wheat," Humphries and Biffen* define strength as the capacity of a flour to yield large well-

* "Journal of Agricultural Science," Vol. II.

piled loaves. They found that as a rule the wheats with the largest nitrogen content gave the strongest flours, but this rule was by no means absolute. They showed that where wheats were grown under similar conditions the nitrogen contents was a fairly satisfactory index of strength; when, however, conditions as to soil or climate varied, this did not hold. The results obtained by various manurial treatments were not consistent, and at Woburn* the effect of manures on strength as determined by baking trials was so small as to be negligible.

Professor Wood† has examined this question of " strength " from the chemical side and has devised methods of grading flours under two heads according (1) to the size of loaf which the flour will produce, and (2) the factors which go to determine the shape of the loaf. The first of those methods as employed by Wood consists of making dough from the flour in the same manner as the baker and noting the amount of gas given off as fermentation proceeds, the evolution of the gas as well as its total volume should be noted. This gas (carbonic acid) is produced by the fermentation of the sugars present in the flour and is the cause of the dough rising. As fermentation proceeds sugars are also produced by diastatic action from the other carbohydrates of the flour. In the ordinary process of making bread the flour is mixed with warm water and yeast until a uniform dough is obtained; this is allowed to rest for some hours, when fermentation sets in and the dough rises. It is then made into loaves, and these are again allowed to remain for some time before being put into the oven. During this time further evolution of gas takes place and it is quite likely that this "second rise," as it has been termed by Hays and Boss,‡ is a very important factor in determining the size of the loaf. The loaves are then placed in the oven, where their shape and size are soon fixed by the formation of the crust. Fermentation, if it has not already ceased, is soon stopped owing to the death of the yeast.

The experiments which I have made with Egyptian wheats have been confined to the first of these methods, *viz.* the size of the loaf

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* "Journal R.A.S.E." Various Annual Reports on Experiments on Wheat.

† " Journal of Agricultural Science," Vol. II.

‡ Minnesota Agric. Ex. St. Bulletin 62.

as determined by measurement of the gas evolved on fermenting the flour with yeast.

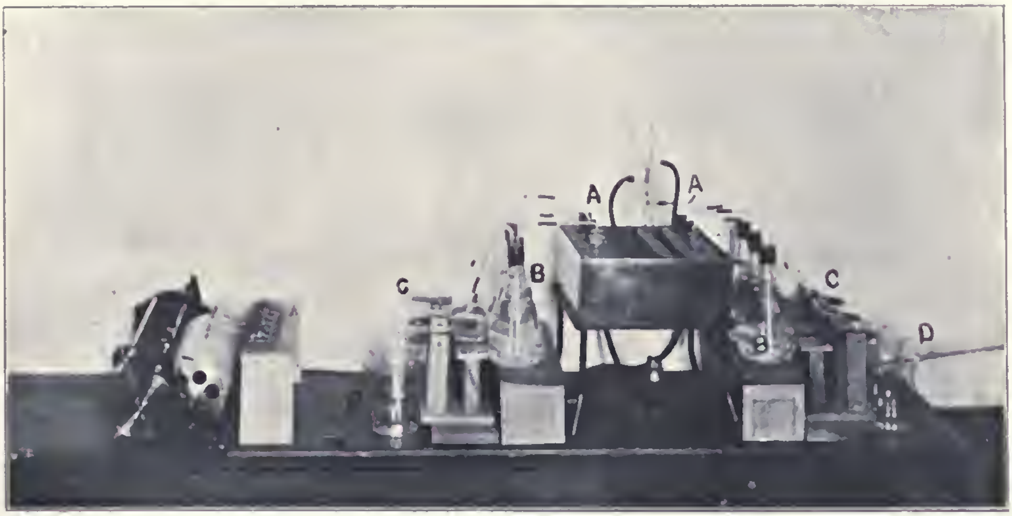
In testing flour in the laboratory one takes twenty grammes of flour and mixes with twenty cubic centimetres of water in which is suspended half a gramme of fresh yeast. These are thoroughly mixed together in a small conical flask or wide-mouthed bottle until a uniform dough is produced. The flask is furnished with a well-fitting cork and delivery tube. By means of a water-bath the flask is maintained at a temperature of 35° C.; this is the optimum temperature for the fermentation by yeast. The gas evolved as fermentation proceeds is collected over water in a graduated cylinder. If readings of the volume of gas are now taken at regular intervals, we get the data necessary to plot such a curve as shown in Figure 1. To get over the difficulty introduced by variations in the fermentative power of different specimens of yeast, it is desirable to make a number of tests at the same time with different flours. The best plan is then to weigh out some yeast and mix it with sufficient water to give a mixture containing half a gramme of yeast in twenty cubic centimetres; the necessary quantity of this mixture can then be added to each weighed portion of flour by means of a pipette. Figure 1 shows the results obtained with three varieties of imported flour. It is interesting to note how exactly the curves correspond to the merchant's description of the samples. The Roumanian wheat was reported as being a very strong wheat. Of the two English wheats one was stated to have moderate strength while the other was considered as weak. It will be seen that the quantity of gas evolved is in accordance with the merchant's description.

In examining a number of Egyptian wheats it was soon found that owing to the variation in the quality of the yeast and the difficulty of obtaining yeast in a perfectly fresh state, the time taken for the fermentation to come to an end was sometimes unduly prolonged, and indeed occasionally fermentation did not commence until several hours after the mixing of the dough. Under these circumstances it seemed desirable to set up some automatic device which would secure a time record of the evolution of the gas. In the apparatus employed the gas, as evolved from the dough, was caused to displace an equal volume of water from a second flask. This water, as it fell from the delivery tube of the flask, was caught in a small tipping spoon.

The spoon was so balanced that when nearly full it tilted, the wate was emptied out into a beaker below, and the spoon returned to its original position. As the spoon tilted it momentarily completed an electric circuit. In each of these circuits was an electro-magnet, to the armature of which a pen was attached. The pens (six in number) recorded on a long horizontal drum making one revolution in twenty-four hours. Under ordinary circumstances the pens would rule straight lines on the chart, but when the apparatus was working the trace was somewhat like Figure 2, which is a reproduction of an actual record. This record is easily translated into a curve such as is shown in Figure 1. Each time the spoon is emptied the pen is drawn aside, the number of dashes shows how many times the spoon was tilted and the quantity of water collected in the beaker indicates the volume of gas evolved. In two tests of the same flour the following results were obtained. In the first the spoon was upset sixty-three times and 392 cubic centimetres and of water were collected; in the second experiment the spoon was filled and emptied sixty-four times and 394 cubic centimetres of water collected. This will serve to show that the arrangement is reliable.

The general arrangement of the apparatus is shown in Plate I. In the figure, the flask containing the mixture of flour, water, and yeast are shown in the water bath at *A*; the flasks *B* contain water which is displaced by the gas. The water falls into the tipping spoons *C* and from them into the beakers *D* placed below. The arrangements of the pens and recording drum is a simple matter and requires no explanation. In the apparatus employed the clock attached to the recording drum caused the drum to revolve once every half-hour. This was useless for the purpose, and in consequence an auxiliary clock was employed having the hands removed and the hour hand replaced by a pulley of half the diameter of the revolving drum. A thread was wound round this pulley, then round the recording drum, and finally passed over a small pulley suspended above the drum; a small weight was attached to the free end. The thread was so wound that as the clock caused the pulley to revolve so the thread unwound and the weight slowly descended. The falling of the weight caused the recording drum to revolve, the clock simply serving to regulate the speed at which the weight descended. The drum was thus made to

PLATE I.



A.—Flasks containing the mixture of flour, water, and yeast.
B.—Containing water which is displaced by the gas.
C.—Tipping spoons.
D.—Beakers for collecting the whole of the water displaced.

To avoid confusion in the photograph, the battery, electrical connections, clock, etc., are omitted.

revolve once in twenty-four hours. In this way no great strain was put upon the clock, which was an ordinary one-day timepiece. This arrangement is not shown in the figure.

In order to obtain results which shall be strictly comparable it is essential that all the samples of wheat are ground to the same degree of fineness. On the small scale this is somewhat troublesome, as the sifting is by no means easy. It was found after several trials that if the flour was passed through a "90" sieve the results appeared satisfactory. Finer grinding than this is difficult without special appliances. As an example of the effect of the fineness of grinding and sifting on the results of the test the following figure will serve. Some native flour, which is not particularly finely ground, was taken; some of this was sifted through a "90" sieve. Portions of the original flour, that which passed through the sieve and that portion which was retained by the sieve were taken, and the amount of gas given off during fermentation was determined in each. The results were as follows:—

	Cubic Centimetres.	
Flour as purchased. Gas evolved ...	441	451
Portion passing "90" sieve	471	483
Portion retained by "90" sieve ...	317	352

From these figures it is evident that uniformity in grinding and sifting is desirable and even essential if reliable and comparable results are to be obtained.

In Figure 3 are shown the results obtained by this method with three typical Egyptian wheats. It will be noticed that judged by this method *Saʿîdi* wheat appears as a strong wheat. *Fayûmi* would be classed as medium, while the *Hindi* wheat, as usually grown in this country, is a very weak wheat. A number of samples of wheat of various kinds were examined; at the same time the nitrogen content was determined. These results, together with the percentage of bran and the weight of 1,000 seeds, are shown in Table I. This last figure serves to show whether the wheat was well nourished. It will be noticed that the strongest wheat, as estimated by the volume of gas evolved, is the Upper Egypt wheat known as *Gawi*. This is a very hard and horny wheat, giving a flour of a distinct yellow colour. The dough made from this wheat is also strongly coloured.

TABLE I.

Variety.	Where Grown.	Moisture per Cent.	Nitrogen per Cent.	Bran per Cent.	Weight of 1000 Seeds in Grammes.	Gas Evolved from 20 Grammes Flour.
Hindi from Egyptian Seed	—	11·42	1·65	10·5	44·6	259
Hindi from Indian Seed	—	10·46	1·52	9·8	42·7	260
Red *Baladi*	—	11·04	1·48	8·9	46·3	365
White *Baladi*	—	10·36	1·98	10·8	50·8	451
Gawi	Assiût	9·36	2·14	9·3	51·0	504
Hindi	—	11·14	1·62	10·3	38·0	280
White *Saʿidi*	—	10·02	1·60	10·6	45·2	520
Saʿidi F.A.Q.	—	9·86	1·64	10·6	57·2	570
Fayûmi	—	10·06	1·55	9·4	—	470
Beheiri	—	10·74	1·50	9·6	40·5	495
Hindi	Beni Suef ; Basin	9·58	1·65	10·3	36·1	264
„	Beni Suef ; Canal	9·66	1·50	9·6	40·5	250
„	Imported choice white	10·00	1·60	—	—	265

It will be noticed that all the samples of Indian wheat examined gave but a small volume of gas, and hence should, according to this test, be classed as weak wheats. It is of interest to note that Indian wheat grown in Egypt behaves in precisely the same manner as the same class of wheat grown in India. This is the case, even when the Indian wheat has been grown for several years in this country. In Figure 4 are plotted the results obtained with two samples of similar wheat, the one grown in India. the other in Egypt. It will be noticed that the curves are identical, showing that the wheat has, in this respect at any rate, undergone no change. The nitrogen content of the two is also practically the same.

One frequently notices in many of the Egyptian wheats that there are present both red and white grains. The red grains are hard and horny or, as they are sometimes termed, "steely," while the white grains are soft and floury. In Table II are shown the results obtained from two such pairs of grains.

TABLE II.

Variety.		Where Grown.	Moisture per Cent.	Nitrogen per Cent.	Bran per Cent.	Weight of 1000 Seeds in Grammes.	Gas Evolved from 20 Grammes Flour.
No. 7.	White	Giza	11·62	1·57	10·4	40·8	420
—	Red	„	11·22	2·18	10·1	38·5	550
No. 8.	White	„	8·78	1·61	9·4	45·1	301
—	Red	„	8·70	2·56	10·0	42·4	539

It will be noticed that not only is the "strength" very different but the amount of nitrogen present in the red grains is very much greater than that in the white. The great strength of the red grains may possibly be due to their having been harvested in a slightly unripe condition. The time of harvesting has been shown by Humphries and Biffen* to have a considerable effect upon the strength of a wheat.

Experiments carried out for many years on the farm of the Royal Agricultural Society at Woburn have shown that manures have but a slight effect on the quality of the wheat grain. The results have varied from year to year, but it would appear that, speaking generally, the use of mineral manures, *i.e.* potash salts and phosphates, has, as a rule, given a slightly stronger wheat than when nitrogenous manures have been employed by themselves. It is noteworthy that in many years the unmanured plots have given the strongest wheat although the crop has been but small.

In this country an extensive series of experiments on the effects of various combinations of manures on the wheat crop has been carried out near Benha by Mr. Victor Mosseri. The wheat employed for these experiments was the *Hindi* variety. Mr. Mosseri kindly gave me small samples from ten of the typical plots and these were

* "Journal of Agricultural Science," *loc. cit.*

examined by the fermentation test and at the same time determinations were made of the nitrogen. The results are shown in Table III. They show that in this country the effect of manures on the character of the grain is much more strongly marked than at Woburn.

TABLE III.

No.	Manurial Treatment.	Kilogrammes per Feddân.	Gas evolved from 20 Grammes Flour.	Nitrogen Per Cent.
1	Without Manure	—	251	1·44
2	Nitrate of Soda	100	282	1·47
3	Nitrate of Lime ... ... Basic Slag ... ... Sulphate of Potash	125 300 150	388	1·51
4	Sulphate of Ammonia	100	291	1·57
5	Cyanamide	110	275	1·41
6	Nitrate of Soda ... ... Basic Slag ... ... Sulphate of Potash	200 300 150	285	1·60
7	Basic Slag ... ... Sulphate of Potash	300 150	392	1·54
8	Nitrate of Soda ... ... Superphosphate ... ... Sulphate of Potash	100 300 150	322	1·48
9	Farm Yard Manure ... ... Basic Slag	7,500 150	390	1·47
10	Nitrate of Soda ... ... Basic Slag ... ... Sulphate of Potash	100 300 150	404	1·40

With the single exception of Plot 6 the effect of the addition of potash and phosphate has been most marked. In the case of this particular plot it will be noticed that an exceptionally heavy dressing of nitrate of soda was employed, and it may well be that this has exerted an overwhelming effect. To bring out this point more clearly two typical results are plotted in Figure 5. It will be seen that the effeet of the additoin of the mineral manures has been to increase the amount of fermentable material by nearly thirty per cent while the nitrogen eontent of the grain has undergone but little change.

It is true that the Rothamsted and Woburn wheats were judged by aetual baking trials or by experts, while these samples were tested only by fermentation. Still the results obtained by Wood show sueh a elose eonneetion between the "strength" and the amount of gas evolved on treatment with yeast that it is difficult to believe that such a great variation as that shown above would not eause a difference in the baking qualities of the flour.

Aetual baking tests should eertainly be made with flour from wheat grown under similar eonditions to those in the above-mentioned experiment.

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