spoke briefly of the possible effect of dehydrated foods on the trend of national life and policy. It was clear, he thought, that dehydration plant would have to be situated where the food was produced and that we must realize that, with the possible exceptions of vegetables and milk, the dried foods we obtained would, for the most part, be dried overseas. If dried foods had a future it would obviously have profound reactions on the organization of transport and distribution. It was well worth facing this problem now because it would be much more easily dealt with when industries largely wrecked could be reconstituted on new lines than when normal industries would have to be remodelled at considerable loss. In particular, he wanted British agriculture to take advantage of dehydration as a means of getting the maximum production in its natural season. If British agriculture seized its opportunity, he believed the producer of good food would benefit, although the producer of inferior products might rightly regard dehydration as something of a menace.

The quality of dried foods prepared by the methods now being employed was not only high but it was ascertainedly so by assay for palatability, vitamin content, etc., and hence could be guaranteed. This he considered most important from the point of view of efforts to raise the nutritional status of the population as a whole. It was already clear that the price of dried foods would not exceed that of fresh foods and might be less owing to economies in cost of distribution and saving of wastage.

While it was impossible in so large a meeting for discussion to go into any detail, several interesting points were raised. Mr. Nevill Wright and several other speakers stressed the need of urgency and asked for information as to what steps were being taken to push forward with production of dried meat and vegetables. The question was raised as to what were the most suitable types of plant for drying different foods and, in particular, stress was laid on the importance of the efficiency of drying in terms of fuel consumption.

In reply to these points Dr. Kidd and Dr. Bate-Smith stated that stress had intentionally been laid on the importance of the pre- and post-drying treatment of the products and of the temperature limits during drying rather than on the exact specifications of the plant to be used. It was felt, in general, that while some adaptations might be necessary, the drying of meat and vegetables would not necessarily call for completely new types of plant design. In terms of the value of the material the cost of drying was negligible.

Dr. Colgate wanted to know whether it was possible to dry eggs without losing their beating quality, which contributed much to the value of the egg in the baking trade. He had not found even the best spray-dried egg equal to frozen egg pulp. Dr. Bate-Smith said that even egg dried out in a vacuum in a frozen condition had lost its aerating power to about the same extent as the spray-dried egg powder. However, this loss of beating quality could easily be overcome by the simple device of beating at an elevated temperature, for example, 40°. Even really poor spray-dried egg powder would give good aeration if the temperature of beating was raised to 50° or 55°.

Squadron Leader Macrae described experiences in the Royal Air Force. From every point of view these new dried foods were what was wanted. The men liked them and trials had shown that they got more vitamin C from dried cabbage than from fresh. This was due to the fact that the cabbage was dried in such a way as to preserve vitamin C while at the same time destroying enzymes which caused the loss of vitamin C by oxidation during cooking. The foods were easy to prepare and transport and they offered variety.

Mr. Charley and other speakers stressed the importance of easily prepared foods as a factor in family life, while others directed attention to their advantage in communal and emergency feeding. Mr. McLellan wanted more information broadcast as to simple methods for home-drying as an additional means of saving garden and allotment produce for the winter.

During the midday break a buffet lunch was served, and cooked dried foods manufactured by the improved processes described were sampled. Those present thus had an opportunity of confirming the claims made as regards their palatability.

DIGESTIBILITY OF HIGH-EXTRACTION WHEATMEALS

By T. MORAN and J. PACE

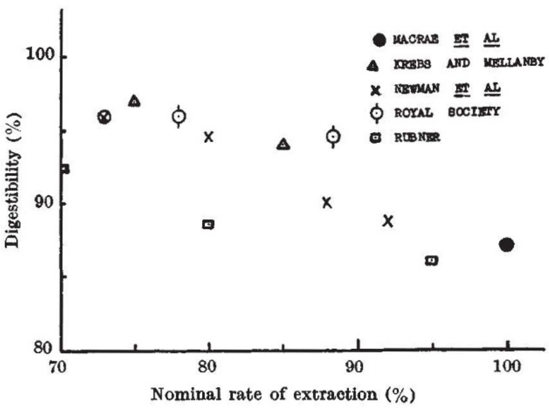
THE digestibility, in terms of energy, by human subjects of high-extraction meals (80–100 per cent extraction) is less than that of flour of 70 per cent or lower extraction. Recent work illustrating this is that of Macrae *et al.*[1], who compared 73 per cent flour with wholemeal (100 per cent), and Krebs and Mellanby[2], who compared 75 per cent flour with a sample of National wheatmeal (85 per cent). Unfortunately, there are no modern data on digestibility for meals between 85 per cent and 100 per cent. Older data exist[3], and it is usually the practice to make the rate of extraction the basis for the comparison of the results of different investigators. In the accompanying figure, these data are plotted in this manner and the wide variation in the results is immediately apparent. In this article we wish to emphasize that in digestibility experiments or calculations on wheatmeals the practice of making the rate of extraction the basis of comparison is fundamentally unsound and may give rise to misleading results and deductions even though the experimental technique of the test meals, etc., is completely satisfactory. At a given extraction the digestibility must depend also on the composition of the wheat grist, the conditioning of the wheat and the method of milling.

The wheat grain consists of endosperm, germ, seed coat (testa, hyaline and aleurone layers) and the shell or pericarp. The layers of the seed coat and pericarp together, with a varying amount of endosperm, constitute the bran; without the endosperm they can be regarded as 'pure bran'.

There seems little doubt, especially in view of the work of Macrae *et al.*[1] on wholemeal, that decrease in digestibility in passing from white flour to high-extraction meals is due to the presence of bran or bran layers rich in indigestible fibrous material. The pericarp or beeswing* includes the layers which

* Beeswing is a general term used by millers and may comprise the whole or part of the pericarp. The actual composition depends on the condition of the wheat and the point of separation in the mill flow; examination of one particular sample from the purifiers showed that it contained all four layers of the pericarp although the amounts of the two inner layers seemed to be slightly less in proportion.

contain the most fibre—two determinations gave figures of 21 and 23 per cent against 14 per cent for pure bran (see below)—and it is the presence of this fraction, either alone or in bran, which is mainly responsible for the lower digestibility of high-extraction meals. Our experience with National wheatmeal shows that the bulk of the contained bran particles are substantially full bran including the aleurone layer.



Fibre content is a sensitive index of the amount of indigestible materials in the bran or its separate layers. The size of bran particle has little or no effect[1]. The white flour basis itself has a small fibre content which is difficult to determine accurately but is in the range 0–0·2 per cent; much of this fibre will be from the cell walls in the endosperm. As we move beyond 73 per cent extraction the increase in fibre content is due mainly to bran or its components.

On the basis that the fall in digestibility is proportional to the fibre content it is possible to calculate theoretical digestibility figures for wheatmeals of different fibre contents. The wholemeal used by Macrae *et al.* had a fibre content (reckoned on a 15 per cent moisture basis) of 1·80 per cent and a digestibility of 87 per cent. The 73 per cent white flour used had a fibre of 0·15 per cent and a digestibility of 96 per cent. On the assumption given above it follows that each increase of 0·2 in fibre content (above 0·15) leads to a decrease in digestibility of about 1·1 per cent. Figures calculated on this basis are shown in Table 1.

TABLE 1.

Fibre content	0·35	0·55	0·75	0·95	1·15	1·35	1·55	1·75	1·95	2·15
Digestibility %	95	93·9	92·8	91·7	90·6	89·5	88·5	87·4	86·3	85·2

The only experimental figure available for checking this is that of Krebs and Mellanby[2], who found a digestibility of 94 per cent for an 85 per cent extraction meal which had a fibre content of 0·45. From Table 1 a meal with this fibre content has a calculated digestibility of 94·4.

It is also possible, taking average figures for the composition of the wheat grain—endosperm and germ 86–87 per cent; pure bran 13–14 per cent—to calculate a figure for the digestibility of pure bran. The figure obtained depends on the value taken for the digestibility of pure endosperm. It is most probable that this is in the limits 97–99 per cent. Taking these limiting figures, the digestibility of pure bran works out at 23 per cent and 11 per cent respectively. The fact that the digestibility of the crude fibre alone in wheatmeal bread is of the same order[1] suggests that the particles of bran pass through the gut substantially unchanged except that the attached endosperm and possibly the aleurone layer are digested. At the same time the vitamin B_1 contained in the bran (including that in the pericarp and testa) must presumably be available since, *in vitro*, it is extracted by dilute acid.

Commercially, bran consists of pure bran plus endosperm, and the digestibility of any commercial sample will depend on the endosperm content.

It is of interest to illustrate the points discussed above by two examples.

Example 1

Typical relative proportions of the various milling fractions and the fibre contents of these fractions have been published[4] (cf. also Table 2). From these data we can compound wheatmeals corresponding to different nominal rates of extraction as follows:

% *Extraction*

80% = 73(*a*) + 5(*e*) + 2(*d*)
85% = 73(*a*) + 5(*e*) + 2(*d*) + 5(*c*)
90% = 73(*a*) + 5(*e*) + 2(*d*) + 6(*c*) + 4(*b*)
95% = 73(*a*) + 5(*e*) + 2(*d*) + 6(*c*) + 9(*b*)
99% = 73(*a*) + 5(*e*) + 2(*d*) + 6(*c*) +13(*b*)

We can calculate the corresponding fibre contents and hence the calculated digestibilities. These data are brought together in Table 2.

TABLE 2.

Milling fraction	% of whole wheat	Fibre %	Rate of extraction %	Calculated Fibre %	Calculated Digestibility
Wheat	100	1·8			
(*a*) Flour	73	0·2	80	0·55	93·9
(*b*) Bran	13	8·0	85	0·90	92·0
(*c*) Fine bran	6	7·0	90	1·30	89·7
(*d*) Purifier tails	2	6·1	95	1·65	87·8
(*e*) Reduction roll tails and mill finish	5	3·6	99	1·80	87·0

Example 2.

Mr. A. G. Simpson has prepared a series of straight-milled high-extraction flours on the experimental milling plant at St. Albans. The grist contained 70 per cent No. 1 Manitoba and 30 per cent English and was milled at approximately 14 per cent moisture giving flours of approximately 13·5 per cent moisture content. The fibre contents of the wheat mixture and the flours were determined and these are shown together with the calculated digestibilities in Table 3.

TABLE 3

Flour or meal (% extraction on a clean wheat basis)	%Fibre (on a 15% moisture basis)	Parts of pure bran	%Digestibility (calculated)
75	Trace	—	97·0+
85	0·55	3·9	93·9
90	1·0	7·1	91·5
95	1·5	10·7	88·7
100	1·95	13·9	86·3

Samples of bran from three varieties of wheat all freed from endosperm by treatment with dilute lactic acid gave fibre contents ranging from 12·9 to 14·2 per cent (on a 15 per cent moisture basis). Similarly, for a wheat mixture of fibre 1·95 per cent (as in Table 3) and assuming it contains 13–14 per cent of pure (clean) bran, calculation gives the fibre content of the pure bran as 14·4 per cent. On the basis of an average fibre of 14 per cent, column 3 in Table 3 gives the equivalent parts of 'pure' bran in each meal.

An average composition of commercial bran (pure bran and endosperm) from wheat conditioned for the milling of white flour is given below together with an analysis calculated for pure bran. This can only be a proximate analysis because the endosperm attached to commercial bran is richer in oil, protein and ash than the bulk of the endosperm. Incidentally, it would appear that the amount of endosperm attached to the commercial bran was approximately 40 per cent; with the drier milling of National wheatmeal the amount of attached endosperm will be much less and figures for the fibre content of the bran may now reach 11·5 per cent, indicating about 18 per cent of endosperm.

TABLE 4

	Commercial bran%	Pure bran%
Moisture	12·5	12·5
Oil	4·7	8·3
N × 5·7	15·0	16·8
Ash	4·7	8·3
Fibre	7·9	14·0
Non-N material	55·2	40·0

Comparison of Tables 2 and 3 illustrates clearly the fact that meals of nominally the same extraction may have quite different fibre contents and hence different digestibilities. The same fact has emerged even more clearly in a survey of National wheatmeal[5].

Apart from the method of milling, the actual fibre content of the wheat mixture used must also be a factor. For individual wheats this may vary[4] from 1·7 to 2·9, with an average for a present-day grist of about 2 per cent.

With increasing extraction the digestibility of each extraction increment will depend upon the corresponding increase in fibre content. As a matter of interest, for the meals in Table 3 the digestibilities of the fractions 85–90 per cent, 90–95 per cent and 95–100 per cent are 50, 40 and 40 per cent respectively.

All the experimental fibre values quoted in this paper were determined by Mr. R. H. Carter by a modification of the official method which he has developed for wheatmeals; each value can be reproduced to within 0·05. We are also indebted to Squadron Leader T. F. Macrae for allowing us to see the typescript of the paper by him and his collaborators now in the press of the *Journal of Hygiene*, and to Dr. C. R. Jones for much helpful criticism.

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[3] Newman, L. F., Robinson, G. W., Halnan, E. T., and Neville, H. A. D., *J. Hyg., Camb.*, **12**, 119 (1912). Rubner, M., quoted by Lusk, "Science of Nutrition" (Saunders & Co.). Royal Society Food (War) Committee, 1918.

[4] Booth, R. G., Carter, R. H., Jones, C. R., and Moran, T., *Chem. and Ind.*, **60**, No. 52, 903 (1941).

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RADIATION FROM THE SUN

By DR. C. E. P. BROOKS

ALL weather, and all life, on the earth are derived ultimately from the sun, and knowledge of the radiation emitted from the sun may be regarded as one of the fundamental sciences. Most of our knowledge of this important subject has resulted from the work and enthusiasm of one man, Dr. C. G. Abbot, of the Astrophysical Observatory of the Smithsonian Institution, who has carried on the work for a generation in the face of many difficulties and much discouragement. The problem is indeed a difficult one, for between the sun and the earth is interposed the atmosphere, and the radiation which reaches the surface is weakened by absorption and scattering. Water vapour, dust, and to a less extent ozone are the worst enemies, and a large part of vol. 6 of the Annals of the Astrophysical Observatory is occupied in describing the continuous attempts to overcome them during the years 1931–1940*. What might have been an even less surmountable enemy, the financial one, has been vanquished mainly with the help of Mr. John A. Roebling.

The difficulties of observation are lessened by making observations at as high a level as possible, to diminish the thickness of the atmosphere traversed by the sun's rays, and in a dry climate to minimize the loss of observations by cloud and also the weakening of the radiation by water vapour. Further, since in spite of all precautions the effect of varying weather conditions cannot be entirely eliminated, several stations must be used distributed as widely as possible in both hemispheres. For the purposes of supply the stations must also be reasonably accessible. Dr. Abbot has sent out many expeditions to test promising localities, but in the present volume the observations from only three are utilized: Montezuma, at a height of 8,895 ft. in Chile, which is the best station; Table Mountain, California (7,500 ft.) and Mount St. Katherine, Egypt (8,500 ft.). Observations were also made for a number of years at Mount Harqua Hala in Arizona, but have not yet been worked up owing to instrumental difficulties, and at Mount Brukkaros in south-west Africa, which though almost cloudless, proved to be too dusty.

The object of the observations is to determine not only the average amount of solar radiation received at the limits of the earth's atmosphere, the so-called 'solar constant', but also its variations from day to day. Since these amount to little more than 1 per cent on either side of the mean (which is still set at 1·94 cal./cm.^{2}/min.) great precision is required both in observation and reduction. Precision in observation is obtained by the refinement of instruments. Direct measurements are made with Abbot's silver-disk pyrheliometer which serves as a permanent standard, and a modified form of Ångström's electrical pyrheliometer to give accuracy and speed in the daily observations. The loss by scattering is given by the pyranometer, which measures the brightness of the sky near the sun and hence the haziness of the air. These instruments give the total radiation falling on them, but since the radiation of different wave-lengths is differently weakened in its passage through the atmosphere, it is also necessary to obtain, with the bolometer, records of the whole

*Annals of the Astrophysical Observatory of the Smithsonian Institution. Vol. 6. By C. G. Abbot, L. B. Aldwich and W. H. Hoover. (Publication No. 3650.) Pp. viii + 207 + 7 plates. (Washington, D.C.: Smithsonian Institution. 1942.)