

Summary

1. Wheat bran, in small amount, is useful as an ingredient of pig and poultry rations, but its use in large amount is contra-indicated, particularly in fattening rations.

2. Wheat offals are useful ingredients of pig and poultry rations, particularly as source of the members of the vitamin B complex, vitamin B₁, riboflavin, nicotinic acid, and pyridoxine.

3. As source of energy for pigs and poultry, the finer wheat offals such as middlings or weatings, are preferable to the coarser ones such as pollards and bran.

4. The manganese content of wheat offals renders these products of value as a source of this trace element in pig and poultry rations.

REFERENCES

- Bartlett, J. M. (1890). *Rep. Me agric. Exp. Sta.* 1889.
 Bauernfeind, J. C., Norris, L. C. and Heuser, G. F. (1942). *Poult. Sci.* **21**, 142.
 Bethke, R. M. and Record, P. R. (1942). *Poult. Sci.* **21**, 147.
 Briggs, G. M. (Jr.), Mills, R. C., Elvehjem, C. A. and Hart, E. B. (1942). *Proc. Soc. exp. Biol., N.Y.*, **51**, 59.
 Briggs, G. M. (Jr.), Mills, R. C., Hegsted, D. M., Elvehjem, C. A. and Hart, E. B. (1942). *Poult. Sci.* **21**, 379.
 Burkett, C. W. (1899). *Bull. N.H. agric. Exp. Sta.* no. 66, p. 111.
 Cooke, W. W. (1891). *Rep. Vt agric. Exp. Sta.* 1890, **4**, 114.
 Gallup, W. D. and Norris, L. C. (1939). *Poult. Sci.* **18**, 76.
 Halman, E. T. (1937). *J. agric. Sci.* **27**, 126.
 Halman, E. T. (1944). *J. agric. Sci.* **34**, 133.
 Harcourt, G. (1891). *Rep. Ont. agric. Coll.* 1890, **16**, 206.
 Jackson, S. H., Doherty, A. and Malone, V. (1943). *Cereal Chem.* **20**, 551.
 Jukes, T. H. and McElroy, L. W. (1943). *Poult. Sci.* **22**, 438.
 Lawes, J. B. (1853). *J. R. agric. Soc.* **14**, 459.
 Mairs, T. I. and Doty, S. W. (1910). *Bull. Pa agric. Exp. Sta.* no. 95.
 Millers' Mutual Association (1933). *J. Minist. Agric.* **40**, 901.
 Poley, W. E. (1938). *Poult. Sci.* **17**, 331.
 Skinner, J. T. and Peterson, W. H. (1928). *J. biol. Chem.* **79**, 679.
 Teply, L. J., Strong, F. M. and Elvehjem, C. A. (1942). *J. Nutrit.* **24**, 167.
 Wood, T. B. and Adie, R. H. (1917). *J. Bd Agric.* **23**, 1179.

General Discussion

Professor J. A. Scott Watson (Ministry of Agriculture and Fisheries, Whitehall, London, S.W.1), opener: Since a great many different interests are concerned with questions of the supply and uses of wheat, from plant breeders and farmers to merchants and bakers as well as consumers, I propose to look at our problem from several points of view.

I have no qualifications to argue the main point that is under discussion today, the pros and cons of enrichment *versus* high extraction, but it happened that I had opportunities to hear American views on the subject and I may perhaps very shortly summarize these.

First of all, there is nearly complete agreement that it would be wrong to leave this whole question to be decided by the consumers themselves. The old business proverb that "the customer is always right" embodies a great lie. We know that the widespread use of low extraction flour has done harm to the generations who have lived since the invention of the roller mill. Some action then is necessary to prevent the recurrence of wholesale malnutrition among those people whose diet includes a large proportion of bread.

In the United States the one view is that we can give the consumer substantially what he needs and also substantially what he wants. Let him, in other words, eat any kind of bread that he likes, from 68 per cent. white to wholemeal, but let it only be seen to that the grosser deficiencies of low extraction flour are made good by appropriate enrichment. Then, with a reasonably mixed diet, nobody need come to any harm.

The other view was put to me by no less an authority than E. V. McCollum. He put the matter thus. It is unquestionable that, in making a low extraction flour, we throw away certain essential nutrients. We now know what some of these things are, and we can replace them, but a little knowledge is a dangerous thing. Can any nutritionist lay his hand on his heart and say that we know enough to enable us to put back all that we have thrown away? McCollum thought not, but I must add that he is one of a relatively small minority. The mass of nutritional opinion, I believe, is in favour of enrichment as a practical policy.

Next, what of the former users of the finer grades of wheat offals, the future disposal of which is under discussion? As regards the milk producer I find myself in complete agreement with Professor Kay. Middlings, weatings, or whatever we like to call these materials, are not, as such, in any way essential to the cowkeeper, nor is there any tradition about their use for milk production which would require to be broken down. Wheat offals supply energy and protein in certain amounts; the other factors which they contain, such as the B vitamins, are of no interest to the cow. In normal times the milk producer has used wheat offals when they have been relatively cheap and, when they have been relatively dear, has turned over to other materials.

It is rather a different case with the pig and the fowl. True, a satisfactory diet for either can be produced without fine wheat offals, but the pig or poultry farmer knows how to compound efficient rations with these offals, and he must, to some extent, relearn his business if he has to go without. In the meantime, some degree of inefficiency would be inevitable. In this connexion I think it is only right to remind this group that producers of pigs, and of poultry and eggs, have suffered very real hardships during the war. When we speak of vested interests, we generally think in terms of big business or high finance. This vested interest of the pig or poultry farmer is the usually modest livelihood that he used to make, and which, during the war, he has not been able to make out of the job that he knows.

The baker and the miller have obviously one interest in common. They want large quantities of bread to be sold. Hence they are concerned that bread should be as good as possible in both senses; on the one hand they want the consumer to have confidence in its nutritive qualities and, on the other, they want to give every consumer what he or she prefers, as a matter of taste, white or brown, coarse or fine. The present American policy, of providing all types, and of enriching the low extraction flours, is naturally popular with the trading interests.

Not quite last and certainly not least, is the interest of the wheat producer, more particularly of the specialist wheat producer like the Canadian prairie farmer. He too depends for his living on the wheat market and there is no other farm product that he can produce so well, or so cheaply, in relation to its quality. It is easy to tell him that, in a

hungry world, there should be no difficulty in his finding a market, but he remembers the time, between the wars, when the price of wheat fell to such a level that he could not buy a shirt for his boy, and when the township school was closed because there was no money to pay the teacher. He knows also that today, but for the use of vast quantities of wheat as a raw material for synthetic rubber, his commodity would be in very great over-supply. The difference between 82 and 72 per cent. extraction means a good deal in terms of total demand; moreover, the wheat grower also is anxious lest some consumers be offered only an article that is distasteful, another vested interest, no doubt, but one that means a great deal to a body of decent, industrious people who are struggling to make a living.

I should like, in conclusion, to say a word about the plant breeders who concern themselves with the production of improved wheats. Already they have done great things. In the Australian wheat country, where the limiting factor is rainfall, they have doubled the former yield of grain for every inch of rain that falls. In Canada where the limiting factor is the frost free period, they have reduced the old five months' growing period to less than a hundred days. Until quite recently their criterion of quality has been based entirely upon consumers' taste, that is they have aimed at producing a wheat that, when milled and baked, would give an open, well piled loaf, snow white inside and with an attractive brown crust. They could take other criteria. There is a wide range of genetic material to work with, so that if consumers wanted more vitamin B₁ or riboflavin or what not, I have little doubt that they could produce varieties having the desired characteristics. On the other hand, if the vitamin B₁ or riboflavin is to be thrown to the cows, then they might as well save themselves the trouble.

Very interesting possibilities are now opening up in regard to wheat breeding. You probably know that wheat came into being by the accidental hybridization of wild grasses with the formation, by very rare accidents, of polyploid forms. The wild grasses concerned have 14 chromosomes. Some wheats are tetraploid with 28, while the bulk of modern types is hexaploid with 42. It is now possible to produce such polyploid forms almost at will, and this line of research is being actively pursued. Hybrids of wheat and rye with 56 chromosomes, have been produced in Russia and Germany, and allopolyploids of wheat with various species of couch grass are showing promise. By this means we can have wheats or perhaps we should say wheat like plants with increased resistance to drought or frost, and we can have perennial as well as annual forms. Although it is too soon to speak with certainty, it seems that we now have the power further to extend the range of wheat cultivation if and when such expansion is desired. All those involved from the plant breeder to the baker, are concerned in the business of producing the consumers' bread, and all would, I believe, admit that the well being of the consumer is the paramount consideration, but clearly, if this end can be attained by different means then, when the choice is made, other considerations must be duly weighed.

Professor R. Nicolaysen (Nutrition Institute, The University, Oslo):
Of the total consumption of flour before the war in Norway 38 per cent.
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was derived from rye of 67 per cent. extraction and 8 from rye of 95 per cent. extraction, while wheat of 73 and 95 per cent. extraction supplied, respectively, 40 and 10 per cent. The remaining 4 per cent. was made up of small amounts of different flours. The vitamin B₁ content of rye flour of 67 per cent. extraction is 1.3 I.U. per g. as against 0.4 I.U. for 73 per cent. extraction wheat flour. Rye bran contains only 2 to 3 I.U. per g. while wheat bran has 6 to 7 I.U. per g. Experiments in Norway showed that, apart from crude fibre which was better digested by sheep, men, sheep and pigs digested equally well the various components of bran. The digestibility of the protein, pentosans and so forth of bran decreased with increasing extraction; thus the bran included in 85 per cent. extraction flour was better digested than that present in one of 95 per cent. extraction (Breirem and Nicolaysen, 1942).

REFERENCE

- Breirem, K. and Nicolaysen, R. (1942), *Ash. norske Vidensk.Akad. I, mat. naturv. Kl. no. 2.*

Dr. A. B. Anderson (Glasgow Royal Infirmary): There is a variable factor in bread which is of some importance and has not yet been mentioned. I refer to the content of common salt. This amounts usually to about 1 per cent. of the loaf, but in Glasgow there is as much as 1.5 per cent. This high salt content must be borne in mind when planning low salt diets, especially for out patients.

Professor R. A. Peters (Department of Biochemistry, University Museum, Oxford): Could Mr. Halnan tell us how much of the wheat of the country would have to be milled to a low extraction to provide the offal needed for poultry?

Mr. E. T. Halnan replied: If we assume a peace time poultry population of 60,000,000 and allow per hen per year one cwt. of food, half of which consists of grain and the other of mash, 1,500,000 tons of mash would be needed. If 60 per cent. of this mash consists of wheat offals 900,000 tons annually would be required. To produce this amount from 70 per cent. extraction flour milling, 3,000,000 tons of wheat would be necessary. With 85 per cent. extraction flour milling, 6,000,000 tons of wheat would have to be milled. However, since the bread consumption of the population is fairly stable in spite of price fluctuations, the amount of wheat milled for flour is not likely to alter. The adoption of the loaf produced from 85 per cent. extraction flour must therefore lead to a reduction in the home produced milling offals available for poultry. If egg production were to be based on such offals only, the question after the war might be: shall we be satisfied with a slice of wholemeal standard bread and butter for breakfast or should we rather have a slice of white bread and an egg?

Mr. F. Le Gros Clark (6 East Common, Harpenden, Herts.): Why bother to go over the grain like this, could not the grain be processed as a whole and fed?

Professor J. A. Scott Watson (Ministry of Agriculture and Fisheries, Whitehall, London, S.W.1): There is no difficulty about using wheat as

such for animals. One could introduce 25 per cent. of it into the ration of a dairy cow and more into those of other animals. I met a farmer who said that he was feeding 100 per cent. of wheat to his pigs during their lifetime. It must be remembered, however, that while wheat has been used as such for feeding animals it is only under exceptional circumstances that we should wish to do it, since maize can be produced much more cheaply.

Dr. E. Kodicek (Dunn Nutritional Laboratory, Cambridge): As pigs and poultry seem to be, according to the previous speakers, the two species which may seriously compete with man for high extraction flour, or at least for certain fractions contained in it, would it not be possible, if no other solution can be found, to enrich the rations of these animals rather than the bread of man? If it is true that we know enough about all the essential factors needed for enrichment, should we not try out this knowledge on the chick and on the pig before we apply it to man?

Dr. F. Bergel (Roche Products, Ltd., Broadwater Road, Welwyn Garden City, Herts.): Professor Kay has remarked that the cow does not need the vitamin B complex as it is synthesized by her ruminal flora. I should like to ask, however, whether these organisms can live and grow without obtaining from the food of the cow certain vitamins or bios factors. I feel that one should be very cautious in the application of microbiological tests for vitamins. I understand, for example, that pantothenic alcohol is twice as active for animals as pantothenic acid though it is without effect on *Lactobacillus*.

Dr. C. Crowther (79 Cheam Road, Ewell, Surrey): The lowering of the quality of wheat by-products involved in the higher rates of flour extraction does not create any serious practical problem in the feeding of ruminants. Neither the pig nor the fowl has, however, any appreciable power of digesting fibre, and the fibre factor needs, therefore, to be taken into account with them. In its general arrangement for the utilization of food the pig approximates to man more nearly than any other farm animal.

There is perhaps a tendency to concentrate attention too closely upon the direct nutritive factors, whereas indirect factors, such as palatability, suitability and bulk, often prove to have a dominant influence upon the practical success of a diet. This is well illustrated by the bulk factor, of which the fibre content is a rough measure, and this needs careful consideration in war time dietaries since in nearly every case where an item of pre-war character and quality has to be replaced, the substitute is bulkier and all too often more fibrous. The cumulative effect may be that a dietary, even when consumed to the extreme limits of appetite, proves inadequate to cover essential requirements. I am not familiar with the literature of experimental work on the bearing of this factor upon human nutrition but for the pig and the fowl there is definite experimental evidence of an optimum, roughly measured by fibre content, above or below which maximum efficiency of food utilization cannot be obtained although there may not be any disturbance of general health.

Professor L. S. P. Davidson (Department of Medicine, University of Edinburgh): The National 85 per cent. extraction flour has no deleterious

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effect on the human being even when he is suffering from inflammatory or irritating conditions of the gastro-intestinal tract. I have had experience over the last 3 years and it has convinced me, and all my colleagues in the Dietetic Out Patient Department, that nothing but good has come from the use of 85 per cent. extraction bread.

Concerning the reference to rickets in Ireland, I would point out that there had been no properly controlled investigation of rickets in Dublin prior to the consumption of the high extraction bread; recent experience in this country has underlined the difficulties of such surveys (British Paediatric Association, 1944). Dr. Kent-Jones has suggested that the experience in Newfoundland with enriched flour might yield valuable information. I should doubt it. Newfoundland is a place where cod fishing is one of the staple industries. Dr. W. R. Aykroyd told me long ago that the best examples of vitamin A deficiency were found there despite cod being on the spot.

REFERENCE

British Paediatric Association (1944). *Rep. publ. Hlth med. Subj., Lond.*, no. 92.

Dr. D. W. Kent-Jones (88 Madeley Road, Ealing, London, W.5): Regarding Professor Davidson's observations and the earlier remarks of Mr. Wood, I should like to say that my reading of the work in Dublin is that the diet generally may have been poor but that there was no great change in the intake of vitamin D before and after the serious increase in rickets which coincided with the increase in the extraction to 100 per cent.

Dr. L. J. Harris (Dunn Nutritional Laboratory, Cambridge): Arising out of the comments of Professor Davidson and Dr. Kent-Jones, it is only fair to recall that Dr. Jessop and his colleagues (Fitzgerald, Sheehan, Collis, Pringle, Reynolds and Jessop, 1944), in the last of their series of three papers on "The Incidence of Rickets in Dublin", show due scientific caution about the conclusions which can be drawn from their observations. They write:

"The interval between the introduction of our present 85 per cent. extraction flour and the period of the survey was hardly sufficient to allow us to observe fully what effect, if any, the change is likely to produce on the incidence of rickets. . . . The incidence of rickets in Dublin in spring, 1944, was very high. The maximum incidence in the children from each source occurred in the age group 7—12 months. The proportion of children receiving an adequate intake of milk and vitamin D is very low."

REFERENCE

Fitzgerald, H. D., Sheehan, N. E., Collis, W. R. F., Pringle, H., Reynolds, R. A. and Jessop, W. J. E. (1944). *J. med. Ass. Eire*, 15, 54.

Dr. D. W. Kent-Jones: Dr. Harris has read the wrong paper, I quoted the previous one.

Mr. A. L. Bacharach (Glaxo Laboratories, Ltd., Greenford, Middlesex): The quotation is from Croasdaile, Collis, Pringle and Jessop (1943), and is as follows:

"From the above findings it appears that some children have developed rickets in spite of a calcium intake which would be adequate if no extra-ordinary factors preventing absorption were present. Others have developed the disease in spite of an intake of vitamin D which ought to have been adequate. The most obvious conclusion is, therefore, that the phytic acid can render insoluble such a high proportion of the calcium ingested that there is not sufficient left for adequate absorption, even in the presence of vitamin D. It is, of course, possible that the presence of very large amounts of vitamin D might effect the absorption of calcium in spite of the phytic acid, but this point has not been the subject of investigation up to the present."

REFERENCE

Croasdaile, H. V., Collis, W. R. F., Pringle, H. and Jessop, W. J. E. (1943)
J. med. Ass. Eire, 12, 69.

Wing Commander T. F. Macrae, R.A.F.V.R. (R.A.F. Institute of Pathology and Tropical Medicine): I would not agree with Dr. Kent-Jones that nutrition workers in the U.S.A. are unanimous in support of the enrichment policy. My own experience is that many, among them at least two very eminent workers, consider it a bad policy. The improvement in the nutrition of the people in the U.S.A. during the last 2 or 3 years cannot be attributed to the bread policy. The war has brought better wages to the poorest and I think that most workers in America consider that the improvement is due to this rather than to "enriched" bread.

Canada Approved flour gives a white bread, indistinguishable, to the ordinary citizen, from ordinary white bread. Indeed one baker in Ottawa with a big business bakes only Canada Approved and sells it as ordinary white bread to customers asking for this. The fact that only 7 per cent. of the total bread consumed is Canada Approved must, therefore, be due rather to the lack of desire of the millers to produce the flour and of the bakers to bake it, than to the failure of the public to purchase the bread.

Dr. H. E. Magee (Ministry of Health, Whitehall, London, S.W.1): The so called milling offals deserve a better name. They are rich in important nutrients, in protein, iron, all the members of the vitamin B complex, manganese and magnesium. All these are present in higher concentration than in the rest of the wheat berry, and the protein is of higher biological value. Giving offals to farm animals, therefore, amounts to nothing less than giving them the most, and human beings the least, nutritious part of the wheat. It should be the other way round. Professor Kay has pointed out that wheat offals are of little value for milk production, while Mr. Halnan says that they are useful for pigs and fowls but he does not contend that they are any better for these animals than whole wheat or other cereal. He asserts, however, that fowls require relatively large quantities of the B vitamins and of manganese. Here is surely a case where "fortification" seems desirable. In the first place fowls seem to require more of these nutrients than they can get from whole cereals and secondly, fortification is an experimental procedure, and it is much more sensible to try out experiments on animals before imposing them on human beings. The so called enrichment of white

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flour by the addition of some B vitamins and other nutrients does not make sense. To remove by an elaborate process some of the most important nutrients of wheat and then to manufacture, with still greater trouble, a few of these nutrients and add them to white flour, from which they and several others have been extracted, is as near to being crazy as anything could well be. Anyhow, it is not possible at present to add more than three out of the 11 known factors of the vitamin B complex, the unknown factors being altogether ignored. This is not enriching, it is tinkering.

Dr. S..K. Kon (National Institute for Research in Dairying, University of Reading): With Professor Kay's permission I should like to answer the question which Dr. Bergel addressed to him. The cow can grow, reproduce, and secrete milk on diets sufficiently deficient in the vitamin B complex to kill rats in a comparatively short time. The presence of assimilable carbohydrate in the rumen is more important for the synthesis of vitamins than that of vitamin B₁. In refectation, when undigested starch is present in the caecum, rats can grow and thrive on a diet devoid of most members of the vitamin B complex.

Dr. P. Ellinger (Lister Institute, Chelsea Bridge Road, London, S.W.1): There is, apart from beriberi, no vitamin B deficiency disease of human beings which can directly be connected with a diet poor in the respective vitamin. On the other hand evidence is increasing that at least a large proportion of the requirements for members of the vitamin B complex is covered by the release of these vitamins from the intestinal flora. Man seems, therefore, less interested in their consumption than pigs and hens, and it may prove economical to leave the wheat offals to these latter.

Dr. E. Work (I.C.I., Welwyn Garden City, Herts.): In countries such as Denmark where wholemeal bread is eaten, what are the cattle fed on?

Professor J. A. Scott Watson (Ministry of Agriculture and Fisheries, Whitehall, London, S.W.1): They import quantities of milling offals, or did so before the war, from this country; our own stockbreeders had plenty.

Chairman's Summing Up

Professor R. A. Peters (Department of Biochemistry, University Museum, Oxford): I am afraid I find summarizing difficult. I think that the first thing we ought to do is to congratulate the officers and committee for the programme that they have organized and put before us today, and the various speakers for presenting to us so admirably the different aspects of the questions under consideration.

I have of course been a good deal impressed by what Dr. McCance told us about the work at the Cereals Research Station under Dr. Moran, a most interesting piece of research. It is extremely important that it should go on so that we can learn more and more about it.

It would seem that there is every cause for letting the cows have the bran, I have been convinced of that. That brings us down to the 85 per cent. extraction as recommended some years ago. With regard to the question of offals, it would seem again from what we have heard about