

THE LANCET

Extra Iron in Food

IRON-DEFICIENCY anaemia is widespread, especially among women of child-bearing age. An estimate from W.H.O.¹ puts the worldwide prevalence at 20%. One of the solutions advocated is to give everybody extra iron in bread, but there are serious doubts about its value. An editorial in 1968² cited ELWOOD's view that the British practice of adding powdered electrolytically precipitated iron to flour was useless: ELWOOD then favoured ferric ammonium citrate, and he and his colleagues have since reported on the effect of adding this iron salt to flour used to bake bread.³ Two community-based studies were organised. In the first "therapeutic" trial a group of moderately anemic women (haemoglobin not less than 8 g. per 100 ml.) were selected; 304 of them started the trial and 237 completed it 9 months later. Half the women used standard or white bread containing the regulation powdered iron; the other half had bread baked from flour containing ferric ammonium citrate in an amount that gave each about 1 mg. of iron daily. The second "prophylactic" trial was more elaborate. All the anemic women in a large community sample were identified and treated with oral iron. Then a sample of these women were given bread made from flour containing ferric ammonium citrate in a larger amount than in the first trial, so that each subject got about 2.7 mg. iron daily; the effect was assessed by the degree to which it prevented a subsequent fall in haemoglobin. There were 450 women at the start of the trial, and 322 completed it after 12 months; they were divided into 3 groups. The first group had the special bread giving 2.7 mg. iron daily; the second group used standard white bread containing powdered iron together with a tablet containing 2.7 mg. of iron; and the third group had standard white bread with a placebo tablet. The results were not easy to interpret because the changes were small, but ELWOOD et al. concluded that the therapeutic trial showed no significant benefit from ferric ammonium citrate. The prophylactic trial showed some slight benefit for the special-bread group at 6 months, but after 12 months the differences between the groups were not statistically significant. The results, in their view, confirmed that "iron added to flour used to bake bread is very poorly available to man from a

normal diet". Nor could this poor effect be compensated for by adding more iron, since iron salts induce rancidity on storing and adversely affect baking qualities; indeed, an acceptable loaf giving 2.7 mg. iron a day was produced only with extreme care.

ELWOOD, WATERS, and GREENE⁴ have tested the alternative of giving pharmaceutical iron by asking two groups of women to take regular iron pills. The groups were girls aged 14 and some women who had lately been iron-deficient and whose deficiency had now been corrected; the iron was given as ferrous fumarate and the trial was arranged to last 3 years. They found that a supplement of at least 10 mg. of iron daily was needed to have any effect, but the main difficulty was to keep the participants taking the pills regularly. Tests with an indicator added to the tablets suggested that 70% of the 14-year-olds took their tablets during the first year, but subsequently the proportion fell to around 40%. The adults cooperated better, but ELWOOD and his co-workers think that after 6 months forgetting to take the tablets increased—in fact, they became convinced that long-term administration of tablets was impracticable and that if iron intake was to be supplemented iron would have to be added to a foodstuff. Regrettably, their experiments suggested that 10 mg. iron daily is the minimum effective dose, and this is too much for use in commercial baking.

Another difficulty has arisen in estimating the amount of iron actually available for absorption in food. There has been considerable controversy about the effect of iron-binding substances such as phytate in a mixed diet. JACOBS and GREENMAN,⁵ for example, studied the availability of iron extracted from twenty-five common foodstuffs under conditions resembling those in the normal stomach. They found that, in most foods, less than half the total iron is released into solution, so that determinations of the total dietary iron give a misleading estimate of the effect on the subject's iron levels. In addition, there was quite a surprising variation in the amount of iron in popular foods. For example, in six samples of sirloin steak the iron content after cooking varied from 2.90 mg. to 4.65 mg. (average 3.65 mg.) per 100 g., and in ready-cooked corned beef five samples varied from 2.50 mg. to 9.00 mg. (average 4.51 mg.) per 100 g. In another set of experiments they measured the recovery of ionic iron in the form of ferric nitrate added to peptic digests of some foods; the recovery from a watery solution was 100%, from iron mixed with corned beef 95%, from 'All Bran' 75%, from white bread 57%, and from boiled egg 10%. These figures reflect the well-known inhibiting effect of egg on iron absorption, the possibility⁶ that

1. *Lancet*, 1972, i, 1221.

2. *ibid.* 1968, ii, 495.

3. Elwood, P. C., Waters, W. E., Sweetnam, P. *Clin. Sci.* 1971, 40, 31.

4. Elwood, P. C., Waters, W. E., Greene, W. J. W. *Lancet*, 1970, ii, 175.

5. Jacobs, A., Greenman, D. A. *Br. med. J.* 1969, i, 673.

6. Callender, S. T., Warner, G. T. *Lancet*, 1970, i, 546.

it may be better to add extra iron to brown rather than to white bread, and the importance of meat in the diet.

The importance of meat has been underlined in work by LAYRISSÉ, in Caracas, and FINCH, in Seattle, and their colleagues. They⁷ have devised methods for studying iron absorption by means of test meals containing iron in two forms. In one, animal and vegetable food is marked with an "intrinsic tag", which is ⁵⁵Fe injected into the living animal or incorporated in the growing medium of the vegetables; in the other, solubilised ferric chloride labelled with ⁵⁹Fe is used as an "extrinsic tag" for added iron. They found that such ferric chloride was absorbed just as well as ferrous sulphate, though they admit that the absorption is much better than that from the kind of iron salts, such as ferric orthophosphate and reduced iron, that are suitable for incorporation into commercial bread. Using these methods, LAYRISSÉ et al.⁸ have reported their investigations into the effect of iron fortification of food. Their subjects were 228 Venezuelan peasants who were in apparent good health, though many had iron depletion and even iron-deficiency anaemia. The criteria for anaemia were a haemoglobin of less than 13 g. per 100 ml. for males and 12 g. per 100 ml. for females: 21.5% of the subjects were anæmic, 28.9% were "iron-deficient", and 63% absorbed more than 30% of a test dose of ferrous ascorbate and so were "iron-depleted". Tagged maize and wheat were prepared by growing in hydroponic culture with ⁵⁵Fe. The tagged meat was veal obtained by injecting labelled ferric citrate into 3-month-old calves and killing them for meat 3 months later; the ground veal muscle was made into hamburgers in which about 80% of the iron was present as hæm iron and 15-20% as ferritin. The extrinsic tag of ferric chloride was found to be absorbed in a fashion similar to non-hæm iron present in foods used for diet. The investigators knew that absorption from the non-hæm pool is influenced by the presence of animal protein, and this influence was found to be considerable in the experiments with fortification iron. Thus, iron salt added to a vegetable food showed very limited absorption; an intake of 60 mg. fortification iron led to absorption of 0.3 mg. of iron; whereas a supplement of 5 mg. of iron eaten with a veal hamburger resulted in absorption of 0.85 mg. of iron, which is equivalent to the daily male requirement. When mixtures of animal and vegetable foods, such as are normally taken, were given, the results for absorption of fortification iron were intermediate. Absorption of meat iron was apparently not affected by the dose of non-hæm iron represented as vegetable food or iron

salt. The investigators conclude: "all these studies imply that food iron fortification is likely to be effective only in individuals who take animal protein as part of their diet. They also indicate why the iron content of the diets in certain countries such as India may be high yet provide inadequate iron for a large segment of the population. One must also question the efficacy of giving iron treatment with meals, particularly if these meals contain no animal protein but vegetable foods with strong inhibiting agents for iron absorption. The efficacy will vary whether iron is given before, during, or after meals."

From several years' work on the effect of adding iron to flour emerges the sad conclusion that these supplements are of little value to an iron-deficient population. The solution of the iron-deficiency problem is to be found largely in improved public-health methods, such as better sanitation and education in hygiene, to reduce infestations with such parasites as hookworm and bilharzia, and in education about the best possible use of food materials. Even in affluent Western societies the high and increasing cost of meat and other animal-protein foods is likely to increase the incidence of iron deficiency, especially in mothers with young families. The problem of inadequate iron will not be easy to solve.

FOR DISTINGUISHED AND MERITORIOUS SERVICE IN THE CAUSE OF ... ?

THE word "distinguished" was once used of doctors mainly in their obituaries, or when they were being introduced as visiting lecturers—occasions when, as Johnson said of lapidary inscriptions, "a man is not upon oath". The problem of attaching identifiable meaning to the term arose only when the Spens Committee¹ opined that there would be, within the National Health Service, "individual specialists whose outstanding distinction would merit additional reward". Their invention of distinction awards reflected the fact that, in the free medical market operating up to 1945, specialists' incomes had a range of tenfold between highest and lowest. The early history is well known—a small committee dominated by its chairman, Lord Moran, based its selection of holders on personal judgment as well as objective criteria. Equally well known is the lack of equality in their distribution, geographically and between specialties, which predictably, where such large sums of money were concerned, gave rise to continual complaint and criticism. The Pilkington Commission² examined the system with care but concluded that it was "a practical and imaginative way of securing a reasonable differentiation of income and providing relatively high earnings for the 'significant minority'." However, they recommended that C awards might be allocated, or potential holders nominated, by com-

7. Cook, J. D., Layrisse, M., Martínez-Torres, C., Walter, R., Mosen, C., Finch, C. A. *J. clin. Invest.* 1972, 51, 805; Layrisse, M., Martínez-Torres, C. *Am. J. clin. Nutr.* 1972, 25, 401.

8. Layrisse, M., Martínez-Torres, C., Cook, J. D., Walter, R., Finch, C. A. *Blood*, 1973, 41, 333.

1. Inter-departmental Committee on the Remuneration of Consultants and Specialists. Cmmd. 1420. H.M. Stationery Office, 1948.

2. Royal Commission on Doctors' and Dentists' Remuneration. Cmmd. 939. H.M. Stationery Office, 1960.