INDUSTRIAL NUTRITION

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PREFACE

During recent years interest in the relationship between the nutrition of industrial workers and their health and efficiency has greatly increased. Study of the feeding of workers is not, however, a new development. In 1924, when unemployment was widespread, the Medical Research Council [1] investigated the adequacy of the diet of coal-miners and their families; and in 1936 the International Labour Office issued a report [2] on workers' nutrition and social policy. The practical importance of the application of nutritional principles to the conditions existing in industry was greatly increased in Britain when, in November 1940, the Factories (Canteens) Order was passed directing any factory employing more than 250 people to make satisfactory arrangements for the establishment and maintenance of a suitable canteen where hot meals could be purchased by the factory workers. The Order was at first applied only to factories engaged on munitions work, but in April 1943 it was extended to cover all factories doing work considered to be in the national interest.

Those responsible for the well-being of industrial workers quickly appreciated that the provision of adequate meals, designed to ensure that the total daily diet of each worker was nutritionally adequate for his needs, was not only an important forward step in social practice, but was also calculated to increase industrial efficiency. To-day very many factories maintain canteens of their own free will.

[1] Medical Research Council, 1924. Sp. Rept. Ser. 87.

[2] I.L.O. 1936. Studies and Rept. Ser. B. (Econ. Conditions), 23.

A number of books have been published describing how industrial canteens should be run and giving instructions on efficient and economical methods of cooking and of preparing meals. Although some of these books briefly review the general principles of nutrition, there does not at the present time appear to be in existence any reasoned discussion of the special nutritional needs of people working under the practical conditions of industrial life to-day. Dietary customs and habits vary widely in different parts of the country and between one industry and another. Behind all these different dietary patterns, however, lie the basic principles of nutritional science. In this book I have tried to review the available evidence showing how the different types of work carried out by people of different ages and of the two sexes affect their nutritional requirements, and how meals can best be arranged within the varied conditions of industrial life to provide different groups of people with their nutritional needs. This discussion may perhaps provide something of value to all those who have an interest in, or who are responsible for, industrial workers to-day, as well as to those who are students of nutrition. In particular, I hope that it will be useful to the many hundreds of industrial caterers who during the past ten years and more have consistently shown their interest in acquiring a knowledge of the principles upon which their practice must be based if it is finally to be successful.

As these words are being written, the subject of industrial nutrition is of critical importance in this country. During a period when the British food supply has been consistently exiguous, the long-drawn effort to increase the efficiency of the worker and the output of industry continues unabated.

Some of the work described in these pages was carried out when I had the advantage of the stimulation of daily

contact with Sir Jack Drummond, F.R.S., and I should like to acknowledge his encouragement here. My thanks are also due to Miss D. Johnston, Deputy Chief Inspector of Factories, who was always ready to give me friendly advice and assistance. I must acknowledge the technical co-operation of my late colleague, Miss M. Ainslie.

M. P.

Blairlogie.
December, 1949.

CONTENTS

CHAP.		PAGE
I.	General Problems of Industrial Nutrition	1
II.	The Need for Calories	12
III.	The Significance of Fat	31
IV.	Protein, Meat and Work	46
V.	Accessory Food Factors	59
VI.	Food Wastage and the Effects of Cooking	76
VII.	Meal Frequency and the Working Day	91
VIII.	Nutrition in Light Industry	105
IX.	Hot and Heavy Work and the Effect of Fumes on Nutritional Needs	120
X.	The Coal-miner	133
XI.	The Outdoor Worker	151
XII.	Feeding the Night Shift	160
XIII.	Adolescents	178
XIV.	Likes, Dislikes and Nutrition	191
	Author Index	200
	Subject Index	202

Chapter One

GENERAL PROBLEMS OF INDUSTRIAL NUTRITION

FEEDING in industry and the problems of industrial canteens cannot be considered separately from the more general subject of human nutrition as a whole. One of the mistakes of the Industrial Revolution has been that the workers in a factory or the miners in a pit have in the past been thought of as if, once they were at work in the large numbers necessitated by modern industrial life, they had become a special species of being, different from an ordinary person. Even to-day "factory meals", "the works canteen" or "the mid-shift snack" are sometimes studied as problems on their own and not, as they must be, as part of the diet of men and women who happen to spend some of their day at a particular job. In a moment we shall, perforce, be discussing the scientific aspects of nutrition as they affect the industrial worker, but before we do so we must take, as the first principle of successful catering, the fact that workpeople in factories, whose nutrition we are proposing to consider, are first of all *people*. It is painfully easy to find oneself thinking of two dozen of one's fellow-creatures as twenty-three "joints" and a "fish pie".

Industrial nutrition is concerned with the feeding of people. If, then, the first principle of the successful application of scientific nutrition is to remember that the subject applies to *people*, the second principle is that nutrition depends on *food*. An infinite variety of diets, composed of a multitude of types of foods cooked in many different ways, are to be found among the peoples of the world. Some of these diets are nutritionally adequate for health, and some of them are not. " A little of what you fancy does you good " may sometimes be true, but it is very often not so. Some of the men and women who filed into the Armed Forces in the nineteen-forties could claim to possess perfect nutrition, but very many of them could not. To-day those same men and women, and others like them in factories, mines, docks and workshops, still show signs of a nutritional status capable of improvement. And, furthermore, they are each day in need of a diet sufficient to enable them effectively to meet the demands of their day's work. An appreciation of the principles of nutrition and an understanding of how such principles can be applied under industrial conditions can alone enable this need surely to be fulfilled.

Human nutrition is a branch of applied physiology. As such it is a science that takes no account of the subjective feelings of the people being fed. While it is true that " man does not live by bread alone ", it is equally true that the nutritional well-being of the animal species *homo sapiens* is as little affected by his likes and dislikes as are the nutritional requirements of experimental rats confined in a laboratory. From the rigid standpoint of animal physiology, the average nutritional requirements of groups of people are fixed, and are based on such measurable characteristics as sex, age, height, weight, degree of activity, rate of growth and sexual maturity. Furthermore, when average groups are considered, there are no exceptions to the laws of physiology. The nutritional needs of similar individuals are the same wherever in the globe they happen to live and whatever type of diet they may happen to be accustomed to eat.

The nutritional needs of similar individuals are the same, but their customary diets may be very different. The variety of diets eaten in different parts of the world is infinite. Many groups of people subsist on inadequate diets, and suffer in consequence. But it may happen that diverse diets equally well provide the nutritional needs of those eating them.

For example, in 1946 a study[1] was made of the state of nutrition of the Otomi Indians in the Mezquital Valley in Mexico. The health of these Indians was found to be good, yet they were eating very few of the foods usually considered in the Western world to be necessary for a good diet. They ate little meat, dairy produce, fruit or vegetables. Instead they made their meals from tortillas and from local plants such as malva, hediondilla, tuna, nopales, maguey, garambullo, yucca, purslane, pigweed, sorrel, wild mustard flowers, *lengua de vaca*, sow-thistle and cactus fruit. And they drank pulque, an intoxicating beverage made from the juice of the century plant. Yet when the components of the Otomi Indians' diet were flown to the Massachusetts Institute of Technology and analysed,[2] it was found that they provided a better nutritional balance than was present in the diet of a group of United States town-dwellers surveyed at the same time.[3]

The lesson to be learnt from this by the student of industrial nutrition is that, no matter how unusual a traditional diet may appear, it ought never to be condemned until its nutritional composition is known. It is upon this basis alone that nutritional adequacy can be assessed.

[1] Anderson, Calvo, Serrano and Payne, 1946, *Amer. J. Pub. Health*, 36, 883.
[2] Gravioto *et. al.*, 1945, *J. Nutrition*, 29, 317.
[3] Lockhart *et al.*, 1944, *J. Amer. Dietet. Ass.*, 20, 742.

Although nutrition makes itself felt in terms of food, a soundly based diet cannot be established in terms of beef-steak, bread, doughnuts or any other food. It must first be expressed as nutrients.

A food can be defined as anything which when digested can do one or more of three things: (*a*) furnish the body with material from which it can produce heat, work or other forms of energy; (*b*) provide material to enable growth, repair or reproduction to proceed; (*c*) supply substances which normally regulate the production of energy or the process of growth, repair or reproduction. *Nutrients* are the components of foods which enable them to exert one or other of these functions, and hence to be defined as food.

The most fundamental of the three attributes of food is the provision of energy. One difference between a living body and a dead one is that the temperature of the living body is maintained, its muscles exert a positional tension even during sleep, blood circulates and breathing continues. Energy is required to keep the bodily machine "ticking over" thus. It was Lavoisier who in Paris at the end of the eighteenth century first established that the human engine, like any other mechanical machine, obeys the laws of thermo-dynamics. He also observed that the energy used up by the body was derived from food.

It requires about 70 calories of energy an hour to keep the basal functions of an average man's body going. The exact amount needed by an individual is proportional to his body-size. It is largely for this reason that whereas an average man consumes 70 calories an hour in keeping himself alive, an average woman, being smaller, uses only about 60 calories an hour.

These are the requirements for "ticking over" only. When the machine is "put into gear", additional fuel is consumed. Merely to sit requires 15 calories an hour over and above the basal metabolic needs; to stand requires an extra 20 calories an hour; walking at moderate speed uses 200 calories and climbing stairs 1,000 calories an hour. The varied activities of a sedentary man when added to his basal requirement call for a daily expenditure of about 2,500 calories. A sedentary woman needs 2,100 calories daily. Manual workers expend from 3,000 to, say, 4,500 calories, depending on the arduousness of their jobs. If people do not obtain from their diet the calories they need, three things happen: (*a*) they become hungry, (*b*) they do less work and (*c*) they consume the substances of their body and become thinner.

Just as it is possible to determine the calorific value of different specimens of coal when comparing their qualities as fuel, so can the calorie value of different foods be measured so that they may be compared as sources of energy. An ounce of butter provides 212 calories, an ounce of sugar 108, an ounce of bread 70, of potato 25 and of cabbage—a watery food—7 calories. The first measure of the adequacy of the diet for a man is the comparison of the calorie requirements of the individual, or of the several groups comprising the working population, with the total calorie content of all the different commodities making up the daily diet.

The fundamental feature of a planned diet must be that it shall make provision for there being enough to eat—that is to say, for an adequate supply of calories. The second feature is that the foods providing the calories shall be selected so that a practical meal can be constructed from them. For example, in times of difficulty an Irish peasant can subsist almost entirely on potatoes. Since an ounce of potato provides 25 calories, it is necessary for a moderately active man, whose total needs are, say, 3,000 calories a day, to eat 120 oz. of potatoes in a day, or, say, $2\frac{1}{2}$ lb. at each of three successive meals. This is inconvenient, to say the least, for an industrial worker. The second aspect of the planned diet, therefore, so far as calories are concerned, is the recognition of the differing energy value in fats, sugar, cereals, meat and other food commodities.

The analogy between the animal body and a mechanical engine cannot be taken too far. Although the production of mechanical energy is a primary function of food, it is not the only function. The components of muscular tissue, of bones, of teeth and of blood must all be derived from food. The nutrients serving these purposes are, first, proteins and their components, to be found in animal foods such as milk, meat, fish and eggs and, though often in less favourable proportions, in cereals and other vegetable foods. Mineral elements, notably calcium, iron, phosphorus and many others, from which such special structures as bones, teeth and blood-cells are built up, must also be derived from the foods comprising the diet.

Finally there are a number of complex enzymes needed by the body to maintain in action the slow-combustion processes of life. Many of these enzymes can be built up by the body from the basic chemical elements of which foods are composed, but, on the other hand, certain of them cannot be elaborated unless important sections are available "prefabricated" in one or other of the foods comprising the diet. These pre-fabricated sections are the *vitamins*.

The diet of a man must therefore provide sufficient energy for life and work, and it must also supply nutrients such as protein, fat, calcium and iron, from which the body-structure is composed. Finally, it must supply the quantitative needs of a series of vitamins and other accessory food factors.

The requirements of every category of individual in terms of nutrients are known. In 1935 a technical commission of the League of Nations[1] drew up a table of the nutritional needs of children, adults, workers and adolescents and other special groups such as expectant and nursing mothers. This table was gradually modified and extended as scientific knowledge became more complete, until to-day, after estimates published in 1943 had been revised first in 1945 and then in 1948, the recommended nutrient allowances of the Food and Nutrition Board of the U.S. National Research Council[2] can be accepted as the amounts of the different components of which a diet is made up which will certainly produce optimum nutritional health. Many individuals can consume a diet providing less than the National Research Council recommendations and still be adequately nourished; no group of people, however, would benefit from being given more. The allowances for those categories of folk in whom the industrial nutritionist is interested are shown in Table 1.

The usefulness of a knowledge of nutrition to people who are responsible for feeding industrial workers rests on its enabling them, first, to draw up just such a table as that shown overleaf; and secondly, in giving the information as to which foods and how much of them must be included in a diet so that it may provide the amounts of necessary nutrients.

The most direct way in which industrial work affects the nutritional requirements of the worker is through its calls on the body for physical energy, and hence its demand on the diet for calories. This is an important practical matter which has not been adequately studied under practical conditions. The scientific literature contains a considerable

[1] "Report on the Physiological Basis of Nutrition", 1935, Geneva, Pub. iii, Health, 6.

[2] U.S. National Research Council, Reprint and Circular Ser. No. 115, 1943; 122, 1945; 129, 1948.

TABLE 1

Recommended Daily Dietary Allowances

	Calories	Protein, g.	Calcium, g.	Iron, mg.	Vitamin A, i.u.	Vitamin B[1], mg.	Riboflavin, mg.	Niacin, mg.	Vitamin C, mg.	Vitamin D, i.u.
Men (weighing 154 lb.)										
Sedentary .	2,400	70	1·0	12	5,000	1·2	1·8	12	75	—
Physically active . .	3,000	70	1·0	12	5,000	1·5	1·8	15	75	—
With heavy work . .	4,500	70	1·0	12	5,000	1·8	1·8	18	75	—
Women (weighing 123 lb.)										
Sedentary .	2,000	60	1·0	12	5,000	1·0	1·5	10	70	—
Moderately active . .	2,400	60	1·0	12	5,000	1·2	1·5	12	70	—
Very active .	3,000	60	1·0.	12	5,000	1·5	1·5	15	70	—
Boys										
13–15 yrs. (103 lb.) . .	3,200	85	1·4	15	5,000	1·5	2·0	15	90	400
16–20 yrs. (141 lb.) . .	3,800	100	1·4 .	15	6,000	1·7	2·5	17	100	400
Girls										
13–15 yrs. (108 lb.) . .	2,600	80	1·3	15	5,000	1·3	2·0	13	80	400
16–20 yrs. (119 lb.) . .	2,400	75	1·0	15	5,000	1·2	1·8	12	80	400

amount of information about the energy requirements of work. Much of this is, however, academic and out of date, and hence of limited value to those who have practical tasks of feeding actual workers. For example, it is traditional in the scientific text-books to mention, as an example of an industrial occupation, the energy requirements of a stonemason chiselling a tombstone ! [1]

Knowledge of the physical demands of the work carried out in a factory is important for the intelligent designing of the diets of the workers. For example, in one plant " heavy press operation " may be a man's job calling for strenuous physical work, whereas elsewhere a task with the same name

[1] Becker and Hamalainen, 1914, *Skand. Arch. Physiol.*, 31, 198.

may be done almost entirely with automatic mechanical equipment, and perhaps even by a female operative.

The basic requirement of a good diet is that it should provide the amounts of nutrients shown in Table 1. These nutrients, however, must be supplied as food, and the food must be provided as meals. The appropriate number of meals for an individual doing a particular job is a matter of considerable nutritional interest. It is also a subject upon which finality has not been reached. Part of the uncertainty on the subject arises from confused thinking and a lack of accurate observations. For example, it is often assumed that people usually eat three meals a day. This, however, is very rarely so. If a meal is defined in nutritional terms it has to be described in some such words as: "a meal is any occasion during which food providing at least 200 calories is consumed at one sitting". When this type of definition is applied, we find that some of the working people in Britain and elsewhere eat four meals a day, most of them eat five, and those who have breakfast, a mid-shift snack, dinner, another snack, tea and supper, eat six meals a day. The choice of a dietary pattern appropriate to the type of job a worker is doing always affects his or her contentment and well-being. It may be also important for the maintenance of health, and will certainly affect the efficiency with which the work is done.

Besides the frequency of an industrial worker's daily meals, their timing is also a matter of nutritional significance. Shift work affects the conventional pattern of the daily diet. Even a slight change in the timing of the working hours may profoundly change the type of meal best suited to the men or women concerned, and will in consequence change the type of meal the works canteen should supply if it is to do its job properly. The most extreme example of the influence