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FOODS: NUTRITIVE VALUE AND COST.

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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., October 23, 1894.

SIR: I have the honor to transmit herewith, for publication as a Farmers' Bulletin, an article on the nutritive value and pecuniary economy of foods, prepared by Prof. W. O. Atwater, PH. D., of Wesleyan University, special agent in charge of food investigations. This article has been prepared under that clause of the act of Congress making appropriations for this Department for the current fiscal year which provides funds "to enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for human food," with suggestions of less wasteful and more economical dietaries than those in common use. As this is the first of a series of popular bulletins on the nutritive value and economy of food which this Office intends to prepare, it has been deemed wise to confine its scope to a careful definition of technical terms, tables and explanations showing the nutritive value of common food materials and the ways in which they may be combined in dietaries on the basis of their actual value as food, and some general considerations concerning the pecuniary economy of food, with suggestions regarding wastes to be avoided. There are of course great difficulties in the way of the clear and accurate popular presentation of the results of scientific research on so complex a subject as human nutrition, but it is believed that a careful perusal of this bulletin will at least enable the reader to see the relation between the nutritive value and the cost of foods, and will greatly aid him in understanding the discussion of other phases of this subject in succeeding bulletins.

Respectfully,

A. C. TRUE,
Director.

Hon. CHAS. W. DABNEY, JR.,
Acting Secretary.

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FOODS: NUTRITIVE VALUE AND COST

THE NUTRIMENT IN FOOD AND HOW IT IS USED IN THE BODY.

A quart of milk, three-quarters of a pound of moderately fat beef, sirloin steak for instance, and five ounces of wheat flour, all contain about the same amount of nutritive material; but we pay different prices for them and they have different values for nutriment. The milk comes nearest to being a perfect food. It contains all of the different kinds of nutritive materials that the body needs. Bread made from the wheat flour will support life. It contains all of the necessary ingredients for nourishment, but not in the proportions best adapted for ordinary use. A man might live on beef alone, but it would be a very one-sided and imperfect diet. But meat and bread together make the essentials of a healthful diet. Such are the facts of experience. The advancing science of later years explains them. This explanation takes into account, not simply quantities of meat and bread and milk and other materials which we eat, but also the nutritive ingredients or "nutrients" which they contain.

CHEMICAL COMPOSITION OF FOOD MATERIALS—QUANTITIES OF NUTRIENTS.

Edible portion and refuse.—If the reader will take the pains to notice the next piece of beef that he has to carve for dinner he will observe, first of all, that along with the meat which is good to eat there is more or less of bone, which, except in so far as it may be used for soup, is of no value for food. If, however, the meat man has already cut out the bone, only the edible portion will be left. Beef, then, consists of edible portion and refuse. The same is true of fish, in which the bones and entrails and sometimes the skin are the refuse. In eggs there is a corresponding distinction between the shells and the so-called "meat." The inside of the potato and the wheat flour are the edible portion, and the skin and bran are the refuse of the potato and wheat.

If we weigh the whole meat, bone and all, to start with, and afterward weigh bone and meat separately, we can easily calculate the percentages of refuse and edible portion. The proportions of refuse are from 8 to 10 per cent in a round of beef, about 14 per cent in eggs, 18 per cent in a leg of mutton, 40 per cent in chicken, and 50 per cent or more in some kinds of fish. In such food materials as milk, flour, and bread there is of course no refuse.

Water and nutrients.—Meat freed from bone, milk, and flour all contain more or less water. This can be dried out by heating, as is done in the chemical analysis of food materials. The proportions of water in different food materials vary greatly. Ordinary flour contains about 12½ per cent, or one-eighth. The fatter kinds of meat have from 15 to 50 per cent and the leaner meats from 50 to 75 per cent of water. One-third of the weight of bread and three-fourths of the weight of potatoes consist of water. The water in all these substances is precisely the same as any other water and has no more value for nutriment.

The material which remains in the edible portion of the food after removal of the water is called by chemists "water-free substance." It includes all of the actually nutritive ingredients or nutrients of the food. The nutrients are of several kinds. They are commonly divided into four classes called protein, fats, carbohydrates, and mineral matters. Water permeates all parts of the body and is indispensable for nourishment, but the water of the food is not transformed in the body as are the protein, fats, and carbohydrates, and it is not usually taken into account in estimates of nutritive value.

Protein.—Meat consists of lean and fat. Part of the fat is in large lumps, which can be easily separated from the lean. Indeed, we often cut out the fat of the meat which is served on our plates at the table and reject it. But a portion of the fat is in very fine particles diffused throughout the lean. Much of this finely divided fat is in particles so small as to be invisible to the naked eye, but it is possible to separate them very completely from the lean by processes of analysis common in the laboratory. After the water and the fat have been removed from the lean meat, the material which remains will contain a little mineral matter, which would be left as ash if it were burned; the rest consists chiefly of so called protein compounds. The protein is the chief nutritive constituent of fish and eggs as well as of lean meat. The albumen and casein of milk are also protein compounds. The gluten of wheat consists of protein compounds. These compounds occur in corn, beans, potatoes, and indeed all kinds of vegetable foods.

One trouble in speaking of these substances is that they are known by so many different names. The terms "nitrogenous compounds," "albuminoids," and "proteids" are often applied to them. The first term is very proper, because the protein compounds contain the element nitrogen, which is not found in the other classes of nutrients. The term "albuminoids" comes from albumen, a substance familiar to us in the white of egg, and is applied to the compounds which are similar to albumen. Some writers prefer the word "proteids" for substances of this class.

Along with the muscle the meat contains tendon and cartilage, which are familiarly called gristle. These materials and the ossein, or "animal matter" of bone, are very similar to gelatin (glue), and are changed to gelatin on heating with water. They are hence termed gelatinoids. The gelatinoids are the principal ingredients of tendon and similar tissues, while the albuminoids are the chief ingredients of muscle.

There is still another class of nitrogenous substances in meat, which, though small in quantity, are very interesting. They are known in the chemical laboratory as creatin, creatinin, carnin, etc., and are grouped together as "extractives," because they are extracted from flesh by water. They are the chief constituents of beef tea and most meat extracts.

The albuminoids and gelatinoids may be properly grouped together as proteids. It is customary to use the term protein to include albuminoids, gelatinoids, and extractives.

Fat.—Fat is familiar to us in meat, from which we get it in the form of tallow and lard; in milk, from which it is obtained as butter; and in the various vegetable oils, such as olive oil, cotton-seed oil, and the oils of wheat and corn. Larger or smaller proportions of fat are found in most food materials.

Carbohydrates.—Potatoes, wheat, and corn contain large proportions of starch. Sugar cane and sorghum are rich in sugar. Starch and sugar are very similar in chemical composition and are called carbohydrates. Other carbohydrates are found in animals and plants, such as glycogen or "animal starch," which is found in the liver, and cellulose, which occurs in plants.

Ash.—The mineral matter, or ash, which is left behind when animal or vegetable matter is burned, consists of a variety of chemical compounds commonly called salts, and includes phosphates, sulphates, and chlorides of the metals, calcium, magnesium, potassium, and sodium. Calcium phosphate, or phosphate of lime, is the chief mineral constituent of bone. Common salt is chloride of sodium.

These substances are separated from each other in the laboratory by various methods of analysis. The everyday handling of food materials also involves crude processes of analysis.

We let milk stand; the globules of fat rise in cream, still mingled, however, with water, protein, carbohydrates, and mineral salts. To separate the other ingredients from the fat, the cream is churned. The more perfect this separation—i. e., the more accurate the analysis—the better will be the butter. Put a little rennet into the skimmed milk and the casein, called in chemical language an albuminoid or protein compound, will be curdled and may be freed from the bulk of the water, sugar, and other ingredients by the cheese press. To separate milk sugar, a carbohydrate, from the whey is a simple matter. One may see it done by Swiss shepherds in their Alpine huts. But farmers find it more profitable to put it in the pigpen, the occupants of which are endowed with the happy faculty of transforming the sugar, starch, and other carbohydrates of their food into the fat of pork.

The farm boy who on cold winter mornings goes to the barn to feed the cattle, and solaces himself by taking grain from the wheat bin and chewing it into what he calls "wheat gum," makes, unknowingly, a rough sort of analysis of the wheat. With the crushing of the grain and the action of saliva in his mouth the starch, sugar, and other carbohydrates are separated. Some of the fat, i. e., oil, is also removed, and finds its way with the carbohydrates into the stomach. The tenacious gluten, which contains the albuminoids or protein and constitutes what he calls the gum, is left. When, in the natural order of events, the cows are cared for and the gum is swallowed, its albuminoids enter upon a round of transformation in the boy's body, in the course of which they are changed into other forms of protein, such as albumen of blood or myosin of muscle; or are consumed with the oil and sugar and starch to yield heat to keep his body warm and give him muscular strength for his work or play.

What has been said of the ingredients of food may be briefly recapitulated as follows:

Ordinary food materials, such as meat, fish, eggs, potatoes, wheat, etc., consist of—

Refuse.—As the bones of meat and fish, shells of shellfish, skin of potatoes, bran of wheat, etc.

Edible portion.—As the flesh of meat and fish, the white and yolk of eggs, wheat flour, etc. The edible portion consists of *water* and *nutritive ingredients* or *nutrients.*

The principal kinds of nutritive ingredients are *protein*, *fats*, *carbohydrates*, and *mineral matters.*

The water, refuse, and salt of salted meat and fish are called nonnutrients. In comparing the values of different food materials for nourishment they are left out of account.

CLASSES OF NUTRIENTS.

The following are familiar examples of compounds of each of the four principal classes of nutrients:

- PROTEIN.
  - *Proteids.*
    - *Albuminoids*, e. g., albumen (white of eggs); casein (curd) of milk; myosin, the basis of muscle (lean meat); gluten of wheat, etc.
    - *Gelatinoids*, e. g., collagen of tendons; ossein of bones; which yield gelatin or glue, etc.
  - Meats and fish contain very small quantities of so-called "extractives." They include kreatin and allied compounds, and are the chief ingredients of beef-tea and meat-extract. They contain nitrogen, and hence are commonly classed with protein.
- *Fats*, e. g., fat of meat; fat (butter) of milk; olive oil; oil of corn, wheat, etc.
- *Carbohydrates*, e. g., sugar, starch, cellulose (woody fiber), etc.
- *Mineral matters*, e. g., phosphate of lime, sodium chloride (common salt), etc.

HOW FOOD IS USED IN THE BODY.

Blood and muscle, bone and tendon, brain and nerve—all the organs and tissues of the body—are built from the nutritive ingredients of food. With every motion of the body, and with the exercise of feeling and thought as well, material is consumed and must be resupplied by food. In a sense, the body is a machine. Like other machines it requires material to build up its several parts, to repair them as they are worn out, and to serve as fuel. In some ways it uses this material like a machine; in others it does not. The steam engine gets its power from fuel; the body does the same. In the one case coal or wood, in the other food, is the fuel. In both cases the energy which is latent in the fuel—the potential energy, as it is called in scientific language—is transformed into heat and power. When the coal is burned in the furnace a part of its potential energy is transformed into the mechanical power which the engine uses for its work; the rest is changed to heat which the engine does not utilize and which, therefore, is wasted. The potential energy of the food is transformed in the body into heat and mechanical power. The heat is used to keep the body warm. The mechanical power is employed for muscular work. The material of which the engine is built is very different from that which it uses for fuel, but part of the material which serves the body for fuel also builds it up and keeps it in repair. Furthermore, the body uses its own substance for fuel. This the steam engine can not do at all. The steam engine and the body are alike in that both convert the fuel into heat and mechanical power. They differ in that the body uses the same material for fuel as for building and also consumes its own material for fuel. In its use of fuel the body is much more economical than any engine.

The body is more than a machine. We have not simply organs to build and keep in repair and supply with energy; we have a nervous organization; we have sensibilities and the higher intellectual and spiritual faculties, and the right exercise of these depends upon the right nutrition of the body.

The chief uses of food, then, are two: (1) To form the material of the body and repair its wastes; (2) to yield heat to keep the body warm and muscular and other power for the work it has to do. In forming the tissues and the fluids of the body the food serves for building and repair. In yielding heat and power it serves as fuel.

The different nutrients of food serve the body in different ways. The principal tissue formers are the protein compounds, especially the albuminoids. These make the flesh of the body. They build up and repair the nitrogenous materials, as the muscles and tendons, and supply the albuminoids of the blood, milk, and other fluids. The chief fuel ingredients of the food are the carbohydrates and fats. These are either consumed in the body when the food is eaten or they are stored as fat to be used as occasion demands.

The albumen of eggs, the casein of milk and cheese, the gluten of wheat, the myosin of lean meat, and the other albuminoids of food are transformed into the albuminoids and gelatinoids of the body. Muscle, tendon, and cartilage are made of albuminoids.

The albuminoids of food also serve as fuel. A dog can live on lean meat; he can convert it into muscle, heat, and muscular power. The gelatinoids of food, as the finer particles of tendon and the gelatin, which is dissolved out of bone and meat in making soup, though somewhat similar to the albuminoids in composition, are not tissue formers. But they are used as fuel and hence are valuable nutrients.

The albuminoids are sometimes called "flesh formers" or "muscle formers" because the lean flesh, the muscle, is made from them.

The starch of bread and potatoes, and sugar, are burned in the body to yield heat and power. The fats, such as the fat of meat and butter, serve the same purpose, only they are a more concentrated fuel than the carbohydrates.

The fats of the food are stored in the body. The body also transforms the carbohydrates of food into fat. This fat, and with it that stored from the fat of food, is kept in the body as a reserve of fuel in the most concentrated form. One chief use of the fat stored in the body is for fuel, to be drawn on in case of need.

The different nutrients can to a greater or less extent do one another's work. If the body has not enough of one for fuel it can use another. But while the protein can be burned in the place of fats and carbohydrates, neither of the latter can take the place of the albuminoids in building and repairing the tissues. At the same time the gelatinoids, fats, and carbohydrates, by being consumed themselves, protect the albuminoids from consumption.

THE FUEL VALUE OF FOOD.

Heat and muscular power are forms of force or energy. The energy is developed as the food is consumed in the body. It is measured in the laboratory by means of an apparatus called the calorimeter. The unit commonly used is the calorie, the amount of heat which would raise the temperature of a pound of water four degrees Fahrenheit.

Taking ordinary food materials as they come, the following general estimate has been made for the average amount of heat and energy in 1 pound of each of the classes of nutrients:

	Calories.
In 1 pound of protein	1,860
In 1 pound of fats	4,220
In 1 pound of carbohydrates	1,860

In other words, when we compare the nutrients in respect to their fuel values, their capacities for yielding heat and mechanical power, a pound of protein of lean meat or albumen of egg is just about equivalent to a pound of sugar or starch, and a little over 2 pounds of either would be required to equal a pound of the fat of meat or butter or the body fat.

Before the invention of matches, blacksmiths used to start their fires with iron heated by hammering. The heating of the iron was a case of the conversion of one form of energy into another. The muscular energy of the blacksmith's arm was transformed into the mechanical energy of the descending hammer; when the hammer struck, the energy was imparted to the iron, where it was transmuted into heat, and the iron became red-hot. The energy came from the blacksmith's food. Just how all the energy of the food is disposed of in the body, experimental science has not yet told us. But it is certain that part of it is converted into heat and part into the mechanical energy exerted by the muscles. Some of it may be transformed into electricity.

There is no doubt that intellectual activity, also, is somehow dependent upon the consumption of material which the brain has obtained from the food, but just what substances are consumed to produce brain and nerve force, and how much of each is required for a given quantity of intellectual labor, are questions which the chemist's balance and calorimeter do not answer.

The coal and wood we burn, the plants we grow, the food we eat, and the reserve materials in our bodies are reservoirs of latent energy. The source of that energy is the sun. The science of later years is explaining how the energy of the sun warms and lights our planet; how it is stored in coal and petroleum and wood; and how it is transformed into the heat of the furnace, the light of the lamp, the mechanical power of steam, or into electricity and then into light or heat or mechanical power again. The same energy from the sun is stored in the protein and fats and carbohydrates of food, and the physiologists to-day are telling us how it is transmuted into the heat that warms our bodies and into strength for our work and thought.

What has been said above about the ways in which our food nourishes us may be briefly summarized as follows:

WAYS IN WHICH FOOD IS USED IN THE BODY.

Food supplies the wants of the body in several ways. It either—

- Is used to form the tissues and fluids of the body;
- Is used to repair the wastes of tissues;
- Is stored in the body for future consumption;
- Is consumed as fuel, its potential energy being transformed into heat or muscular energy, or other forms of energy required by the body; or,
- In being consumed protects tissues or other food from consumption.

USES OF THE DIFFERENT CLASSES OF NUTRIENTS.

Protein forms tissue (muscle, tendon, etc., and fat) and serves as fuel. Fats form fatty tissue (not muscle, etc.) and serve as fuel. Carbohydrates are transformed into fat and serve as fuel.	All yield energy in form of heat and muscular strength.

In being themselves burned to yield energy the nutrients protect each other from being consumed. The protein and fats of body tissue are used like those of food. An important use of the carbohydrates and fats is to protect protein (muscle, etc.) from consumption.

DEFINITION OF FOOD AND FOOD ECONOMY.

The views thus presented lead to the following definitions: (1) Food is that which, taken into the body, builds tissues or yields energy; (2) the most healthful food is that which is best fitted to the wants of the user; (3) the cheapest food is that which furnishes the largest amount of nutriment at the least cost; (4) the best food is that which is both most healthful and cheapest.

We have, then, to consider the kinds and amounts of nutrients in different food materials, their digestibility, and the kinds and amounts needed for nourishment by people doing different kinds of work.

NUTRITIVE VALUES OF DIFFERENT FOOD MATERIALS.

The nutritive value of foods depends mainly upon the amounts and proportions of actually nutritive materials which they contain. Of course the digestibility and the ways in which they "agree and disagree" with different people are important factors of the nutritive value. We will consider first the chemical composition.

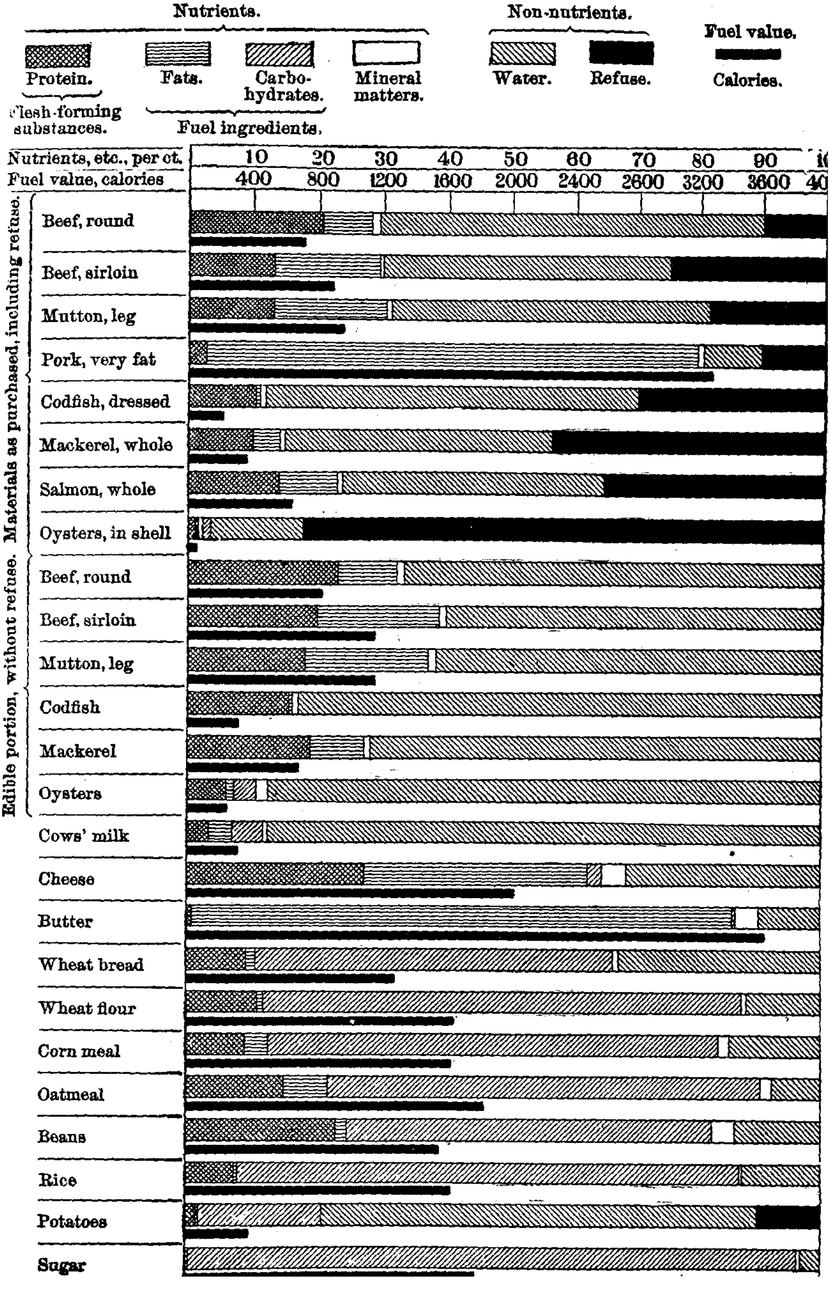
COMPOSITION OF FOOD MATERIALS.

Table A, page 26, gives the percentages of nutrients and the calories of energy found by analysis of specimens of different food materials. Chart 1, page 11, shows the composition of a smaller number, the nutrients, water, and refuse being indicated by bands, and the energy by black lines.

In considering the table and chart it must be remembered that many of our food materials as they are bought in the market include, along with the edible portion, more or less of what is called refuse, like the bone of meat, the shells of eggs, and skin of potatoes. The table and chart show the composition of these materials as we buy them and also the composition of the edible portion. Materials like milk, flour, and bread have no refuse.

Chart 1.—COMPOSITION OF FOOD MATERIALS.

Nutritive ingredients, refuse, and fuel value.



Another important consideration is the amount of water in the edible portion of the food, as also may be seen in Table A. In general, animal foods contain the most water and vegetable foods the most nutrients, though potatoes and turnips are exceptions, the former being three-fourths and the latter nine-tenths water. Butter, on the other hand, though one of the animal foods, generally has ten or more per cent of water. The milk from which it is made is not far from seven-eighths water. Meats have more water in proportion as they have less fats, and *vice versa*, the fatter the meat the less the amount of water in it. Thus, very lean beef (the muscle of a lean animal from which the fat has been trimmed off) may have 78 per cent of water and only 22 per cent of nutrients. The rather fat sirloin may have two-fifths, and very fat pork one-tenth or less of water. The flesh of fish is in general more watery than ordinary meats, that of salmon being five-eighths water, codfish over four-fifths, and flounder over six-sevenths. Flour and meal have but little water, and sugar when well dried has almost none.

In examining the proportions of individual nutrients, protein, fats, and carbohydrates, the most striking fact is the difference between the meats and fish on the one hand and the vegetable foods on the other. The vegetable foods are rich in carbohydrates, like starch and sugar, while the meats have not enough to be worth mentioning. On the other hand, the meats abound in protein and fats, of which the vegetable foods usually have but little. Beans and oatmeal, however, are rich in protein, while fat pork has very little.

In the first glance at a table like this people sometimes obtain a wrong impression. For instance, rice consists of about seven-eighths and potatoes only one-fourth nutritive materials. The first inference is that rice is more than three times as nutritious as potatoes. In one sense this is true; that is to say, a pound of rice contains more than three times as much nutrients as a pound of potatoes. But if we take enough of potatoes to furnish as much nutritive material as the pound of rice, the composition and nutritive value of the two will be just about the same. In cooking the rice we mix water with it, and may thus make a material not very different in composition from potatoes. By drying the potatoes they could be made very similar in composition and food value to rice. Taken as we find them, a pound of rice and 3½ pounds of potatoes would contain nearly equal weights of each class of nutrients and would have about the same nutritive value.

The fats have, weight for weight, about two and one-fourth times the potential energy of either the protein or the carbohydrates. Water has no potential energy. Hence the food materials which have the most fat and the least water have the highest fuel value. Butter and fat pork consist almost exclusively of fat. They lead the other food materials in fuel value. Lard, suet, and olive oil have even less water, and hence exceed the butter in this respect. Oleomargarine (see Table A) has about the same composition, fuel value and food value, as butter.

The different kinds of meat differ even more in proportions of fat than one would suppose from their appearance. The figures given in these tables represent the averages of analyses thus far made of American meats. Comparatively few samples have been analyzed, however, and probably future investigations will change these figures more or less. Indeed meats are so variable in composition that it is very difficult to say just what are the average figures. Generally speaking, veal is the leanest and pork the fattest of ordinary meats. Mutton is apt to be a little fatter than beef. Of the different cuts of beef the loin, rump, and shoulder are among the leanest, while the ribs and flank are the fattest. Mutton and lamb furnish about the same amount of protein and have the same fuel value as the fatter cuts of beef. The loin is the fatter part of beef and mutton. This is especially the case with mutton, because the leaf fat is usually included with the loin as it is sold in the markets, while in the case of beef the tallow and suet, and in the case of swine the leaf lard, are cut out. Pork is so much fatter than the flesh of beef and mutton that even the strictly "lean cuts," as the lean after the removal of the leaf is called, contain relatively as much fat as the fattest cuts of other meats. The case is similar with smoked ham, though the large proportion of fat is due in part to the loss of water in preparation. Among the prepared meats, canned corn beef, which is ordinarily cooked before canning, is worthy of especial notice. It has a large amount of both protein and fats. Like most other kinds of canned meats, the corned beef is free from bone. It furnishes more protein, pound per pound, than most kinds of fresh beef, and stands very high in fuel value.

Chicken and turkey have less fat than the fatter meats. In spite of their large amount of refuse, bone, etc., they furnish quite large quantities of protein.

Fish have in general so much refuse and the flesh contains so much water that the proportions of nutrients are smaller than in ordinary meats. The white-fleshed fish, as cod and haddock, have very little fat. Fish with darker meats, such as shad and mackerel, are rich in fats. Salmon has considerable fat and approaches beef in composition. The difference in composition between dry salt cod and fresh cod is due chiefly to the loss of water in the drying and salting. Many persons are surprised to learn that oysters have about the same proportions of nutrients as milk. Indeed, there is very little difference in the nutritive values of the two when estimated by the quantities of nutrients and energy. Milk is, however, more nearly a "perfect" or "normal" food, if it is right to call any single food perfect or normal. Oysters are so richly prized because of their flavor. Cheese made of whole milk contains nearly all of the nutrients of the milk except the milk sugar, and hence comes very nearly being a concentrated form of milk. Cheese made of skim milk has less fat, and hence relatively more protein.

Among the vegetable foods the chief differences to notice are the proportions of water and of protein. The quantities of water range from

90 per cent or more in beets and turnips to as low as 10 per cent in some kinds of flour. In general, dry seeds, like wheat, corn, and beans, and the different kinds of flour and meal prepared from them, contain not far from one-eighth water and seven-eighths nutrients. Beans and peas contain the largest proportions of protein, and corn meal, potatoes, rice, turnips, and beets the least. Among the cereals wheat is the richest in protein. Doubtless this is one chief reason why it is so largely used for food. Oatmeal has rather more protein than wheat flour.

The comparison of wheat bread with wheat flour is interesting. The chief difference in the composition of flour and bread is the proportion of water, which makes about one-eighth the weight of flour and one-third that of the bread. The average composition of wheat flour and the bakers' bread made from it is about as follows:

Comparison of flour and bread.

	Water.	Nutrients.					Fuel value of 1 pound.
		Total.	Protein.	Fats.	Carbohydrates.	Mineral matters.	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Calories.*
Wheat flour	12	88	12	1	74	1	1,640
Bakers' bread	32	68	9	2	56	1	1,300

In making the bread, a little butter or lard, salt, and yeast, and considerable water, either by itself or in milk, are added to the flour. The yeast causes carbohydrates (sugar, etc.) to ferment, yielding alcohol and carbonic acid in the form of gas, which makes the dough porous. In the baking, the alcohol is changed to vapor and the carbonic acid is expanded, making bread still more porous, and both are mostly driven off. Part of the water escapes with them. The amount of sugar and other carbohydrates lost by the fermentation is not very large, generally from 1½ to 2 per cent of the weight of the flour used. With increase in the proportion of water in the bread as compared with the flour the proportion of nutrients is diminished, but the addition of shortening and salts brings up the fat and minerals in the bread, so that the proportions are larger than in the flour. In practice 100 pounds of flour will make from 133 to 137 pounds of bread, an average being about 136 pounds.

Flour, such as is used by bakers, is now purchased in the Eastern States at not over $4 per barrel. This would make the cost of the flour in a pound of bread about 1½ cents. Allowing one-half cent for the shortening and salt, which is certainly very liberal, the materials for a pound of bread would cost not more than 2 cents. Of course there should be added to this the cost of labor, rent, interest on investment, expense of selling, etc., to make the actual cost to the baker.

Very few accurate weighings and analyses of bakers' bread have been made in this country, so far as I am aware, but the above statements represent the facts as nearly as I have been able to obtain them.

The average weight of a number of specimens of 10-cent loaves purchased in Middletown, Conn., was 1¼ pounds. This makes the price to the consumer 8 cents per pound. The price of bread and the size of the loaf are practically the same now as when flour cost twice as much.

The cost of bakers' bread is a comparatively small matter to the person who only buys a loaf now and then, but in the Eastern States and in the larger towns throughout the country many people, and especially those with moderate incomes and the poor, buy their bread of the baker. Six cents a pound, or even half that amount, for the manufacture and distribution seems a very large amount.

In the large cities competition has made bread much cheaper, but even there the difference between the cost of bread to the well-to-do family who bake it themselves and to the family of the poor man who buys it of the baker is unfortunately large.

THE DIGESTIBILITY OF FOOD.

"We live not upon what we eat, but upon what we digest." In other words, the value of food for nutriment depends not only on how much of nutrients it contains, but also upon how much of these the body digests and uses for its support.

By digestibility of food several different things are, or may be, meant. Some of these, as the ease with which a given food material is digested, the time required for the process, the influence of different substances and conditions on digestion, and the effects upon health and comfort are so dependent upon the peculiarities of different individuals, and are so difficult of measurement as to make the laying down of hard-and-fast rules impossible. For our present purpose, the most important factor is the amount digested. This, fortunately, is more easy to determine. Understanding by the digestibility of a food the proportions of each of the nutrients which can be actually digested by healthy persons, the question can be answered more or less accurately by experiment.

Briefly expressed, the method consists in weighing and analyzing both the food consumed and the solid excrement. Since the latter represents the amount of food undigested and unassimilated, the difference is taken as the amount digested. A large number of such tests of the digestion of feeding stuffs by domestic animals have been made in European, and of late in American, experiment stations. The number of experiments upon the digestibility of food of man is small. Scarcely more than a hundred reliable series have been reported. The very large majority of them have been made in Germany, most of them with healthy men.

The results may be briefly summarized as follows:

(1) The protein of our ordinary meats, fish, and milk is very readily and completely digested. The protein of vegetable foods is much less completely digested than that of animal foods. Of that of potatoes, whole wheat, and rye flour one-fourth, or even one-third may escape

digestion, and thus be useless for nourishment. Roughly speaking, one-sixth or one-seventh of the protein of wheat flour, corn meal, beans, and peas may be assumed to be undigested when cooked and eaten in the usual way.

(2) Much of the fats of animal food may at times fail of digestion. This is presumably true of vegetable fats, but the quantities are in general so small that the determinations of the proportions digested are not very accurate. The experiments thus far made imply that perhaps 5 per cent of the fat of meats, eggs, milk, butter, oleomargarine and lard will escape digestion as they are ordinarily eaten.

(3) The carbohydrates, which make up a large part of vegetable food, are in general very completely digestible. The crude fiber, or cellulose, is an exception, but the quantities of this in the materials used for the food of man are too small to be of importance. Sugar is believed to be completely digested. This is assumed to be the case with the sugar of milk. The other carbohydrates of animal foods are very small in amount.

(4) The animal foods have in general the advantage of the vegetable foods in digestibility in that they contain more protein and that their protein is more digestible.

(5) The quantity digested appears to be less affected by flavor, flavoring materials, and food adjuncts, and to differ less with different persons than is commonly supposed.

One important thing to remember is that the food we digest is not always utilized to the best advantage. Different people differ greatly in this respect. One man may be able to do a large amount of work and another very little when both have the same diet and digest the same amounts of nutrients from it. One person will grow fat upon an amount of digested material with which another will not gain in weight at all. The getting of the most good from food is not so much a matter of digestion as of making use of what is digested.

THE FITTING OF FOOD TO THE NEEDS OF THE BODY.

In the adjusting of diet to the demands of the body, the important matter is to provide enough protein for the building and repair of tissue and enough energy to keep it warm and do its work. Considering the body as a machine, there must be material to make it and keep it in repair and fuel to supply heat and power. If there is not food enough or the nutrients are not in the right proportions, the body will be weak in its structure and inefficient in its work. So, likewise, if there is too much, damage to health will result.

While this is true as a general principle, and while this principle is the fundamental one in food economy, there are many modifications in detail, not as many as there are different persons and different kinds of food to be fitted to their peculiarities of digestion and assimilation, but still very many.

Thus. people in poor health or with weak digestion or with certain peculiarities of the nutritive system, are often obliged to be very particular in the selection of their food. A man who can ordinarily "eat anything" may be forced, in illness, to live on gruel or beef tea. The numerous food preparations for people with weak digestion are made in response to an actual and pressing need of partially digested, or at least of easily digestible, nutriment. Of the meat extracts in the market some contain very little and others practically no material which builds tissue or yields energy. In other words they have little real nutriment and sometimes almost none. They are as much medicine as food, but often their value is inestimable.

There are people who, because of some peculiarity of the alimentary system, are debarred from using foods which for people in general are most wholesome and nutritious. Some persons can not endure eggs, others suffer if they take milk, others have to avoid certain kinds of meat, and others suffer nausea or severe pain if they eat fruits which are generally agreeable to the taste and healthful in their effect. But these are exceptions.

In such matters we are apt to be impressed by the exception rather than the rule. It is nevertheless true for a great majority of people—for nearly every one who is in good health and uses the ordinary standard, wholesome foods—that a healthful diet is that which supplies the quantities of nutrients which the body requires.

Of course there is a great difference in the requirements of different people. The kinds and amounts of food best fitted for nourishment vary not only with sex, age, size, occupation, and climate, but also with the peculiarities of the individual. But it is possible in a general way to estimate the amounts of actual nutrients needed on the average by people of different classes and occupations.

DIETARIES AND DIETARY STANDARDS.

As the outcome of a great deal of observation and experiment, nearly all in Europe, standards have been proposed for the amounts of nutrients and energy in the daily food required by different classes of people. Those of Prof. Voit, of Munich, Germany, are most commonly accepted by specialists in Europe. Voit's standard for a laboring man at moderately hard muscular work calls for about 0.25 pound of protein and quantities of carbohydrates and fats sufficient, with the protein, to yield 3,050 calories of energy. Taking into account the more active life in the United States, and the fact that well-nourished people of the working classes here eat more and do more work than in Europe and in the belief that ample nourishment is necessary for doing the most and the best work, I have ventured to suggest a standard with 0.28 pound of protein and 3,500 calories of energy for the man at moderate muscular work.

TABLE 1.—*American and European dietaries and dietary standards.*

[Quantities per man per day.]

Dietaries.	Nutrients.			Fuel value.	Nutritive ratio.*
	Protein.	Fats.	Carbohydrates.		
American (Massachusetts and Connecticut).	*Lbs.*	*Lbs.*	*Lbs.*	*Cal.*	*1:*
Family of carpenter in Middletown, Conn	.25	.28	.76	3,055	5.5
Family of glass-blowers in East Cambridge, Mass	0.23	0.29	1.06	3,590	8.2
Boarding house, Lowell, Mass.; boarders, operatives in cotton mills	.29	.44	1.21	4,650	7.6
Boarding house, Middletown, Conn.; well-paid machinists, etc., at moderate work: Food purchased	.28	.41	.94	4,010	6.8
Boarding house, Middletown, Conn.; well-paid machinists, etc., at moderate work: Food eaten	.23	.34	.84	3,490	7.3
Blacksmiths, Lowell, at hard work	.44	.67	1.75	6,905	7.4
Brickmakers, Massachusetts; 237 persons at very severe work	.40	.81	2.54	8,850	11
Mechanics, etc., in Massachusetts and Connecticut; average of 4 dietaries of mechanics at severe work	.48	.65	1.65	6,705	6.6
Average of 20 dietaries of wage-workers in Massachusetts and Connecticut	.34	.50	1.38	5,275	7.5
Average of 5 dietaries of professional men and college students in Middletown, Conn: Food purchased	.30	.36	1.12	4,140	6.6
Average of 5 dietaries of professional men and college students in Middletown, Conn: Food eaten	.27	.34	1.08	3,925	6.6
European (English, German, Danish, and Swedish).					
Well-fed tailors, England, Playfair	.29	.09	1.16	3,055	4.7
Hard-worked weavers, England, Playfair	.34	.09	1.37	3,570	4.8
Blacksmiths at active labor, England, Playfair	.39	.16	1.47	4,115	4.7
Mechanic, Munich, 60 years old, in comfortable circumstances, light work, Forster	.26	.15	.76	2,525	4.3
Well-paid mechanics, Munich, Voit	.34	.12	1.06	3,085	4
Carpenters, coopers, locksmiths, Bavaria; average of 11 dietaries, Voit	.27	.08	1.28	3,150	5.3
Miners at severe work, Prussia, Steinheil	.30	.25	1.40	4,195	6.7
Brickmakers (Italians), Munich, diet mainly maize meal and cheese, severe work, Ranke	.37	.26	1.49	4,540	5.6
German army ration, peace footing	.25	.09	1.06	2,800	5
German army ordinary ration, war footing	.30	.13	1.08	3,095	4.6
German army extraordinary ration, in war	.42	.10	1.49	3,985	4.1
University professor, Munich; very little exercise, Ranke	.22	.22	.53	2,325	4.7
Lawyer, Munich, Forster	.18	.28	.49	2,400	6.3
Physician, Munich, Forster	.28	.20	.80	2,830	4.4
Physician, Copenhagen, Jurgensen	.30	.31	.53	2,835	4.1
Average of 7 dietaries of professional men and students, Germany, Denmark, and Sweden	.25	.22	.63	2,670	4.7
Dietary standards.					
Adult in full health, Playfair	.26	.11	1.17	3,140	5.5
Active laborers, Playfair	.34	.16	1.25	3,630	4.7
Man at moderate work, Moleschott	.29	.09	1.21	3,160	4.9
Man at moderate work, Voit	.26	.12	1.10	3,055	5.3
Man at hard work, Voit	.32	.22	.99	3,370	4.7
Man with little physical exercise, Atwater	.20	.20	.66	2,450	5.5
Man with light muscular work, Atwater	.22	.22	.77	2,800	5.7
Man with moderate muscular work, Atwater	.28	.28	.99	3,520	5.8
Man with active muscular work, Atwater	.33	.33	1.10	4,060	5.6
Man with hard muscular work, Atwater	.39	.55	1.43	5,700	6.9

*The nutritive ratio is the ratio of the protein to the sum of all the other nutritive ingredients. The fuel value of the fat is two and a quarter times that of the protein and carbohydrates. In calculating the nutritive ratio the quantity of fats is multiplied by two and one-fourth. This product is added to the weight of the carbohydrates. The sum divided by the weight of the protein gives the nutritive ratio. Materials with large amounts of fats or carbohydrates and little protein, like fat meats or potatoes, have a "wide" nutritive ratio. Those with a large amount of protein as compared with the carbohydrates and fats, like lean meat, codfish, and beans, have a "narrow" nutritive ratio. In other words, the materials rich in tissue-forming substances have a narrow, and those with a large preponderance of fuel materials have a wide, nutritive ratio. This is an important matter in the adjusting of food to the demands of the body.

A well-balanced diet is one which has the right ratio of protein to the fats and carbohydrates. A relative excess of the tissue formers makes the ratio narrow, while an excess of the fuel ingredients makes an overwide ratio in the diet. Either of these errors is disadvantageous. Our food materials and our diet are apt to have too wide a nutritive ratio. In other words, we consume on the whole relatively too little protein and too much of the carbohydrates and fats.

Just what compounds in food are needed for the nutriment of the brain physiological chemistry has yet to tell us, but it is certain that people with little muscular exercise require less food than those who labor. Well-to-do professional men and students in Europe with less muscular exercise than mechanics have been found to be well nourished with an average of 0.23 pound of protein and 2,700 calories of energy. In the cases observed in the United States the amounts eaten by professional men have been much larger.

The figures of Table 1, which are taken from a large number reported by different investigators, will serve to show how the actual dietaries of people of different classes at home and abroad compare with the standard dietaries which have been proposed as the result of observations and experiments. The figures for European dietaries are mostly by Voit and his followers in Germany, and by Playfair in England; the American figures are by the writer and his associates; all are based upon the observations of actual dietaries.

The dietary standards of the same table are intended to represent the average needs as nearly as they can be estimated from the data now at hand. Much more inquiry will be necessary to make them as reliable as is to be desired.

CALCULATION OF DAILY DIETARIES.

On the basis of the standards for dietaries given on page 18, various combinations of food materials for daily dietaries may be made by calculations from Table A (p. 26). Thus if a dietary for a man at moderately hard muscular work is to be made up of round beefsteak, butter, potatoes, and bread, it may be calculated as follows:

		Protein.	Calories.			Protein.	Calories.
		Pounds.				*Pounds.*	
Round steak	1 pound contains	.18	855	Round steak	13 ounces contain	.14	695
Butter	1 pound contains	.01	3,615	Butter	3 ounces contain	....	680
Potatoes	1 pound contains	.019	325	Potatoes	6 ounces contain	.02	320
Wheat bread	1 pound contains	.088	1,280	Wheat bread	22 ounces contain	.12	1,760
					Total	.28	3,455
					Standard for man at moderate muscular work	.28	3,500

A number of different dietaries calculated in this way are given on pages 29–31.

PECUNIARY ECONOMY OF FOOD.

The cost of food is the principal item of the living expenses of most people. The results of investigations into the cost of living of people with different incomes in Massachusetts, in Great Britain, and in Germany, made by the Massachusetts Bureau of Statistics some years ago, are summarized in the following table:

TABLE 2.—*Percentage of family income expended for subsistence.*

	Annual income.	Amount expended for food.	Per cent expended for food.
GERMANY.			
Workingmen	$225 to $300	$140 to $186	62
Intermediate class	450 to 600	248 to 330	55
In easy circumstances	750 to 1,100	375 to 550	50
GREAT BRITAIN.			
Workingmen	500	255	51
MASSACHUSETTS.			
Workingmen	350 to 400	224 to 256	64
Do	450 to 600	284 to 378	63
Do	600 to 750	360 to 450	60
Do	750 to 1,200	420 to 672	56
Do	Above 1,200	612	51

In parts of the West and South where food is very cheap its cost in proportion to other expenses is less, and sometimes falls a little below half the income.

The large majority of families in this country are said to have not over $500 a year to live upon. On the average more than half of this goes, and must go, for food. The cost of preparing food for the table, rent, clothing, and all other expenses must be provided from the remainder.

These statements apply less accurately to farmers than to the inhabitants of the larger towns, but, although the farmer produces much of his food, yet, taking everything into account, the expense for nutriment is large even for him.

Although the cost of food makes so large a part of the whole cost of living, and although the health and strength of all are so intimately connected with and dependent upon their diet, yet even the most intelligent people know less of the actual uses and values of their food for fulfilling its purposes than of almost any other of the necessities of life.

CHEAP VS. DEAR FOOD.

The cheapest food is that which supplies the most nutriment for the least money. The most economical food is that which is the cheapest and at the same time best adapted to the wants of the eater. The maxim that "the best is the cheapest" does not apply to food. The best food in the sense of that which is the finest in appearance and flavor and which is sold at the highest price is not generally the cheapest, nor is it always the most healthful or economical. Yet very many people seem to think that they must have this sort of food, and that to economize by using anything inferior in quality or cheaper in price would be a sacrifice of both dignity and principle.

Mr. Lee Meriwether, who has given much attention to this special subject, cites a case in point, that of a coal laborer who boasted: "No one can say that I do not give my family the best of flour, the finest of sugar, the very best quality of meat." He paid $156 a year for the nicest cuts of meat, which his wife had to cook before 6 in the morning or after half past 6 at night, because she worked all day in a factory. When excellent butter was selling at 25 cents a pound he paid 29 cents for an extra quality. He spent only $108 a year for clothing for his family of 9, and only $72 a year for rent in a close tenement house, where they slept in rooms without windows or closets. He indulged in this extravagance in food when much less expensive food materials, such as regularly come upon the tables of men of wealth, would have been just as nutritious, just as wholesome, and in every way just as good, save in its gratification to pride and palate. He was committing an immense economic blunder. Like thousands of others, he did so without understanding at all that it was a blunder.

Just here is one great difficulty: the lack of information regarding the nutritive values of foods. Even those who wish and try to economize in their purchase and use of food do not understand how. They carefully consult the prices, but have in general very vague ideas about values for nourishment as compared with cost. Persons who are exceedingly economical in purchase of clothing and in other expenditures do not, and in many instances can not, practice intelligently the same economy at the markets. Frequently people pay from $1 to $2 a pound for the protein of the meat and other animal foods they use, when it might be obtained in forms equally wholesome and nutritious for 15 to 50 cents per pound. The food thus purchased is apt to supply some of the nutrients in excessive amounts as well as at needlessly high costs, while it furnishes others in insufficient quantities or in unfitting forms and in uneconomical ways, and only too often a large part of it finds its way into the drain or the garbage barrel instead of being utilized for nourishment. The difficulty is that in comparing different food materials with respect to their cheapness or dearness we are apt to judge them by the prices per pound, quart, or bushel, without much regard to the amounts or kinds of actual nutrients which they contain.

Of the different food materials which the market affords, and which are palatable, nutritious, and otherwise fit for nourishment, what ones are peculiarly the most economical? There are various ways of comparing food materials with respect to the relative cheapness or dearness of their nutritive ingredients. One, and perhaps the best, consists in comparing the nutrients obtained for a given sum in different materials. Estimates of the amounts of nutrients that could be purchased for 25 cents at the rates named are given in Table B (p. 28), and graphically shown in Chart 2 (p. 22). The calculations are based upon the analyses in Table A (p. 26).

CHART 2.—PECUNIARY ECONOMY OF FOOD.

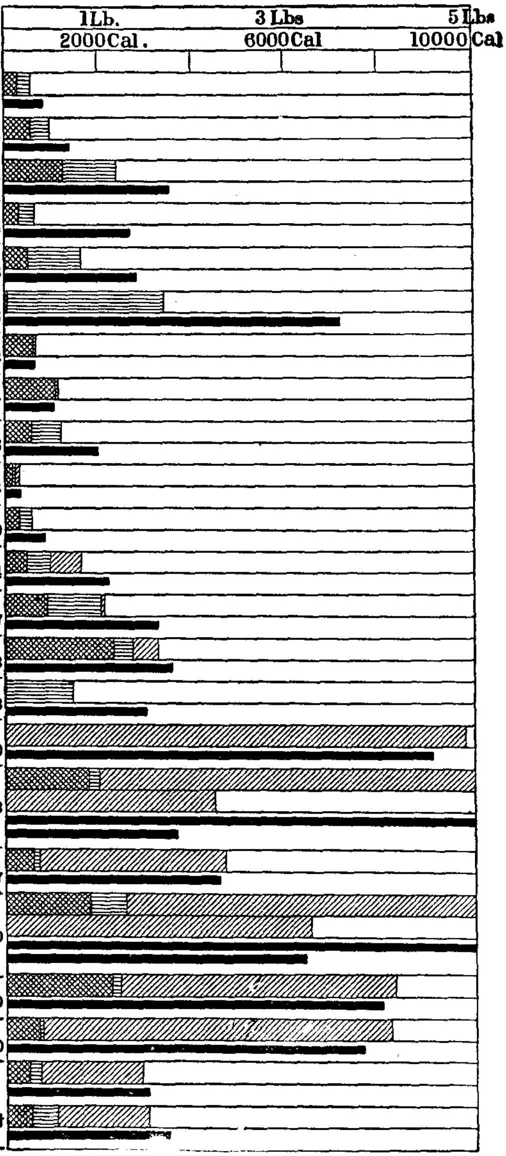
Amounts of actually nutritive ingredients obtained in different food materials for 25 cents.

[Amounts of nutrients in pounds. Fuel value in calories.]

Protein. Fats. Carbohydrates. Fuel value.

	Price per pound.	Food materials for 25 cents.
	Cts.	*Lbs.*
Beef, sirloin	25.0	1.00
Beef, round	15.0	1.67
Beef, neck	6.0	4.17
Mutton, leg	22.0	1.14
Ham, smoked	16.0	1.56
Salt pork, very fat	12.0	2.08
Codfish, fresh	8.0	3.13
Codfish, salt	7.0	3.57
Mackerel, salt	12.0	2.08
Oysters, 35 cents quart	18.0	1.43
Eggs, 25 cents dozen	14.7	1.70
Milk, 7 cents quart	3.5	7.14
Cheese, whole milk	15.0	1.67
Cheese, skim milk	8.0	3.13
Butter	30.0	0.83
Sugar	5.0	5.00
Wheat flour	3.0	8.33
Wheat bread	7.0	3.57
Corn meal	2.5	10.00
Beans	5.0	5.00
Potatoes	1.2	20.00
Standard for daily diet for man at moderate work	German.*	
	American.†	

Weights of nutrients and calories of energy in 25 cents' worth



* Voit. † Atwater.

The figures of Table B tell their story so plainly that they need very little comment. A quarter of a dollar invested in the sirloin of beef at 22 cents per pound pays for one and one-seventh pounds of the meat with three-eighths of a pound of actually nutritive material. This would contain one-sixth of a pound of protein and one-fifth of a pound of fat, and supply 1,120 calories of energy. The same amount of money paid for oysters at the rate of 50 cents per quart brings two ounces of actual nutrients, an ounce of protein, and 230 calories of energy. But in buying wheat flour at $7 a barrel, the 25 cents pay for six and a quarter pounds of nutrients, with eight-tenths of a pound of protein and 11,755 calories of energy.

The price of food is not regulated solely by its value for nutriment. Its agreeableness to the palate or to the buyer's fancy makes a large factor of the current demand and market price. There is no more nutriment in an ounce of protein or fat of the tenderloin of beef than in that of the round or shoulder. The protein of animal food does, however, have an advantage over that of vegetable foods. Animal foods, such as meats, fish, milk, and the like, gratify the palate in ways which most vegetable foods do not, and, what is perhaps of still greater weight in regulating the actual usage of communities by whose demand the prices are regulated, they satisfy a real need by supplying protein and fats, which vegetable foods lack.

People who can afford it, the world over, will have animal foods, and will compete with one another in the prices they give for them. In general, the animal foods are more easily and completely digested than vegetable. There is doubtless good ground for paying somewhat more for the same quantity of nutritive material in the animal food.

For persons in good health the foods in which the nutrients are most expensive are like costly articles of adornment. People who can well afford them may be justified in buying them, but they are not economical.

WASTE OF FOOD.

We waste food in two ways. We throw away a great deal, and many of us eat more than we need. That which is thrown away in the form of kitchen and table refuse does no harm, and in so far as it is used for feeding animals, or, in the case of fat, for making soap, it is not an absolute loss. That which we consume in excess of our needs is worse than wasted, because of the harm it does to the health.

In connection with studies of dietaries by the author and associates in New England, some observations have been made which bear upon this prevalent habit of throwing away valuable food. Thus, in the dietary of a carpenter 7.6 per cent of the total food purchased was left in the kitchen and table wastes. The total waste was somewhat worse than this proportion would imply, because it consisted mostly of the protein and fats, which are more costly than the carbohydrates. The waste contained about one-tenth of the total protein and fat, and only one twenty-fifth of the total carbohydrates of the food; or, to put it in another way, the food purchased contained nearly 10 per cent more protein, 12 per cent more fat, and 5 per cent more carbohydrates than were eaten; and, worst of all, the wasted protein and fats were mostly from the meats, which supplied them in the costliest form.

From the statistics of the amounts and composition of the table and kitchen wastes of a boarding house at Middletown, Conn., it appears that these contained one-ninth of the whole nutritive material of the food purchased. They included one-fifth of the protein and fats and one-twentieth of the carbohydrates. Here again the rejected portions were mostly from the meats. Except in so far as parts of the waste were fed to chickens or possibly used for soap, it was simply thrown away. The boarding house was a very good one, the mistress was counted an excellent housekeeper, and the boarders were mechanics and other thrifty and industrious people with only moderate incomes.

In the studies of dietaries of students' clubs in Middletown it was necessary to determine the weight and composition of the rejected portion of meats. In buying meat in the retail markets in this region it is a common practice to have the bone and considerable of the fat cut out and left. In thus removing the "trimmings" the butcher is apt to cut out considerable else than the bone and fat. In a piece of roast beef weighing 16 pounds, the "trimmings," which consisted of the bone and meat cut out with it, and which were left for the butcher to sell to the soap man or get rid of as he might otherwise choose, weighed 4½ pounds, so that 11½ pounds of meat went to the consumer, who, of course, paid for the whole. The butcher said that he sold this sort of beef largely to the ordinary people of the city—mechanics, small tradesmen, and laborers; that many of his customers preferred not to take the "trimmings;" and that they were not exceptionally large in this case, either in amount or in proportion of meat and bone, for that cut of beef, which was the "rib roast." Inquiries of other meat men brought similar information.

The 4½ pounds of "trimmings" consisted of, approximately, 2¼ pounds of bone and ½ pound of tendon ("gristle"), which would make a most palatable and nutritious soup, and 1¾ pounds of meat, of which 1 pound was lean and ¾ pound fat. It is estimated that the nutritive materials of meat thus left unused, saying nothing of the bone and tendon, contained some 15 per cent of the protein and 10 per cent of the potential energy of the whole. The price of the beef was $2.24. Assuming the nutritive value of the ingredients of the "trimmings" to be 12½ per cent of the whole, 28 cents worth of the nutritive material, besides the bone and tendon, was left at the butcher's.

The common saying that "the average American family wastes as much food as a French family would live upon" is a great exaggeration, but statistics show that there is a great deal of truth in it. Even in some of the most economical families the amount of food wasted, if it could be collected for a month or a year, would prove to be very large, and in many cases the amount would be little less than enormous.

We endeavor to make our diet suit our palate by paying high prices in the market rather than by skillful cooking and tasteful serving at home. We buy more than we need, and what makes the matter worse, it is frequently those who most need to save that are the most wasteful.

The remedy for the evil so far as it applies to the chief item of our living expenses, our food, must be sought in two ways—in an understanding of the elementary facts regarding food and nutrition, and the acceptance of the doctrine that economy is not only respectable, but honorable.

FOOD AND HEALTH.

The studies of dietaries thus far made are not sufficient for entirely reliable inferences regarding the eating habits of the people at large. The total number of dietaries examined is only a little over one hundred. They have been confined mostly to New England; only a small number of the examinations have been made with the needed accuracy; and it is worth noting that the ones in which the amounts and composition of the food have been most accurately determined are for the most part the ones in which the quantities were smallest, although some of the largest of the figures obtained were thought to represent very nearly the actual quantities.

Taking the results as they are, they very decidedly confirm the general impression of hygienists that our diet is one-sided and that we eat too much. The food which we actually eat, leaving out of account that which we throw away, has relatively too little protein and too much fat, starch, and sugar. This is due partly to our large consumption of sugar and partly to our use of such large quantities of fat meats. The quantities of fat in the European dietaries, cited on page 18, range from 1 to 5 ounces per day, while in the American the range is from 4 to 16 ounces. In the daily food of well-to-do professional men in Germany, amply nourished, the quantity of fat is from 3 to 4½ ounces per day; while in the dietaries of Americans in similar conditions of life it ranges from 5 to 7½ ounces in the food purchased. The quantities of carbohydrates in the European dietaries range from 9 to 24 ounces, while in the corresponding American dietaries the carbohydrates were from 24 to 60 ounces.

In the American dietaries the ratio of fuel ingredients to one part of protein ranges from 6.6 to 8.2, and even higher. In the European dietaries of well-nourished people and in the dietary standards which express the average needs according to the teachings of the best physiological observations, it is from 4.1 to 6, or thereabouts. The rejection of so much of the fat of meat at the market and on our plates at the table is not mere willfulness. It is in obedience to nature's protest against a one-sided and excessive diet.

How much harm is done to health by our one-sided and excessive diet no one can say. Physicians tell us that it is very great. Of the vice of overeating, as practiced by the well-to-do classes, in England especially, Sir Henry Thompson, a noted English physician and authority on this subject, says:

"I have come to the conclusion that more than half the disease which embitters the middle and latter part of life is due to avoidable errors in diet, * * * and that more mischief in the form of actual disease, of impaired vigor, and of shortened life accrues to civilized man * * * in England and throughout central Europe from erroneous habits of eating than from the habitual use of alcoholic drink, considerable as I know that evil to be."

APPENDIX.

Table A gives the proportions of ingredients in a number of food materials as found by analysis of specimens collected for the most part in New York and New England markets. They will doubtless be modified by the results of future and more numerous analyses.

The figures of Table B are obtained from Table A, as stated on page 21. The range of prices of the same materials is little if any wider than actually exists at present.

The calculations of Table D are made as explained on page 19. It will be observed that they conform to the dietary standard on page 28, for a "man at moderately hard muscular work."

TABLE A.—*Composition of different food materials.*

Food materials.	Refuse (bones, skin, shell, etc.).	Edible portion.						
		Water.	Nutrients.					Fuel value of 1 pound.
			Total.	Protein.	Fat.	Carbohydrates.	Mineral matters.	
Animal foods, as purchased.								
Beef:	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Cal.
Neck	20	49.6	30.4	15.6	14	....	.8	880
Shoulder	12.6	55.8	31.6	17	13.7	....	.9	895
Chuck rib	14.6	49.5	35.9	15	20.1	....	.8	1,125
Rib	21	38.2	40.8	12.2	27.9	....	.7	1,405
Sirloin	19.5	48.3	32.2	15	16.4	....	.8	970
Round steak	7.8	60.9	31.3	18	12.3	....	1	855
Side, without kidney fat	19.2	44.3	36.5	13.9	21.8	....	.8	1,180
Rump, corned	5	70.8	24.2	16.7	5.1	....	2.4	525
Flank, corned	12.1	43.7	44.2	12.4	29.2	....	2.6	1,460
Veal, shoulder	17.9	56.7	25.4	16.6	7.9	....	.9	640
Mutton:								
Shoulder	16.3	49	34.7	15.1	18.8	....	.8	1,075
Leg	18.1	50.6	31.3	15	15.6	....	.7	935
Loin	15.8	41.5	42.7	12.6	29.5	....	.6	1,480
Side, without kidney fat	17.3	44.2	38.5	14	23.7	....	.8	1,260
Pork:								
Shoulder roast, fresh	14.6	43	42.4	13.6	28	....	.8	1,435
Ham, salted, smoked	11.4	36.8	51.8	14.8	34.6	....	2.4	1,735
Chicken	38.2	44.6	17.2	15.1	1.2	....	.9	330
Turkey	32.4	44.7	22.9	16.1	5.9	....	.9	550
Eggs, in shell	13.7	63.1	23.2	12.1	10.2	....	.9	655
Fish, etc.:								
Flounder, whole	66.8	27.2	6	5.2	.3	....	.5	110
Bluefish, dressed	48.6	43	11.1	9.8	.6	....	.7	210
Codfish, dressed	29.9	58.5	11.6	10.6	.2	....	.8	205
Shad, whole	50.1	35.2	14.7	9.2	4.8	....	.7	375
Mackerel, whole	44.8	40.4	15	10	4.3	....	.7	365
Halibut, dressed	17.7	61.9	20.4	15.1	4.4	....	.9	465
Salmon, whole	35.3	40.6	24.1	14.3	8.8	....	1	635
Salt codfish	42.1	40.5	17.6	16	.4	....	1.2	315
Smoked herring	50.9	19.2	29.9	20.2	8.8	....	.9	745
Salt mackerel	40.4	28.1	31.5	14.7	15.1	....	1.7	910
Canned salmon	4.9	59.3	35.8	19.3	15.3	....	1.2	1,005
Lobsters	62.1	31	6.9	5.5	.7	.1	.6	135
Oysters	82.3	15.4	2.3	1.1	.2	.6	.4	40

TABLE A.—*Composition of different food materials*—Continued.

Food materials.	Refuse (bones, skin, shell, etc.).	Edible portion.						
		Water.	Nutrients.					Fuel value of 1 pound.
			Total.	Protein.	Fat.	Carbohydrates.	Mineral matters.	
Animal foods, edible portion.								
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Cal.*
Beef:								
Neck	...	62	38	19.5	17.5	...	1	1,100
Shoulder	...	63.9	36.1	19.5	15.6	...	1	1,020
Chuck rib	...	58	42	17.6	23.5	...	.9	1,320
Rib	...	48.1	51.9	15.4	35.6	...	.9	1,790
Sirloin	...	60	40	18.5	20.5	...	1	1,210
Round	...	68.2	31.8	20.5	10.1	...	1.2	805
Side, without kidney fat	...	54.8	45.2	17.2	27.1	...	.9	1,465
Rump, corned	...	58.1	41.9	13.3	26.6	...	2	1,370
Flank, corned	...	49.8	50.2	14.2	33	...	3	1,655
Veal, shoulder	...	68.8	31.2	20.2	9.8	...	1.2	790
Mutton:								
Shoulder	...	58.6	41.4	18.1	22.4	...	.9	1,280
Leg	...	61.8	38.2	18.3	19	...	.9	1,140
Loin	...	49.3	50.7	15	35	...	.7	1,755
Side, without kidney fat	...	53.5	46.5	16.9	28.7	...	.9	1,525
Pork:								
Shoulder roast, fresh	...	50.3	49.7	16	32.8	...	.9	1,680
Ham, salted, smoked	...	41.5	58.5	16.7	39.1	...	2.7	1,960
Fat, salted	...	12.1	87.9	.9	82.8	...	4.2	3,510
Sausage:								
Pork	...	41.5	58.8	13.8	42.8	...	2.2	2,065
Bologna	...	62.4	37.6	18.8	15.8	...	3	1,015
Chicken	...	72.2	27.8	24.4	2	...	1.4	540
Turkey	...	66.2	33.8	23.9	8.7	...	1.2	810
Eggs	...	73.8	26.2	14.9	10.5	...	.8	721
Milk	...	87	13	3.6	4	4.7	.7	325
Butter	...	10.5	89	1	85	.5	3	3,615
Oleomargarine	...	11	89.5	.6	85	.4	3	3,605
Cheese:								
Full cream	...	30.2	69.8	28.3	35.5	1.8	4.2	2,070
Skim milk	...	41.3	58.7	38.4	6.8	8.9	4.6	1,165
Fish:								
Flounder	...	84.2	15.8	13.8	.7	...	1.3	285
Haddock	...	81.7	18.3	16.8	.3	...	1.2	325
Codfish	...	82.6	17.4	15.8	.4	...	1.2	310
Shad	...	70.6	29.4	18.6	9.5	...	1.3	745
Mackerel	...	73.4	26.6	18.2	7.1	...	1.3	640
Halibut	...	75.4	24.6	18.3	5.2	...	1.1	560
Salmon	...	63.6	36.4	21.6	13.4	...	1.4	965
Salt cod	...	53.6	...	21.4	.3	...	1.6	410
Herring, salt	...	34.6	...	36.4	15.8	...	1.5	1,345
Mackerel, salt	...	43.4	...	17.3	26.4	...	2.6	1,860
Oysters	...	87.1	12.9	6	1.2	3.7	2	230
Vegetable foods.								
Wheat flour	...	12.5	87.5	11	1.1	74.9	.5	1,645
Graham flour (wheat)	...	13.1	86.9	11.7	1.7	71.7	1.8	1,625
Rye flour	...	13.1	86.9	6.7	.8	78.7	.7	1,625
Buckwheat flour	...	14.6	85.4	6.9	1.4	76.1	1	1,605
Oatmeal	...	7.6	92.4	15.1	7.1	68.2	2	1,850
Corn meal	...	15	85	9.2	3.8	70.6	1.4	1,645
Rice	...	12.4	87.6	7.4	.4	79.4	.4	1,630
Peas	...	12.3	87.7	26.7	1.7	56.4	2.9	1,565
Beans	...	12.6	87.4	23.1	2	59.2	3.1	1,615
Potatoes	...	78.9	21.1	2.1	.1	17.9	1	375
Sweet potatoes	...	71.1	28.9	1.5	.4	26	1	530
Turnips	...	89.4	10.6	1.2	.2	8.2	1	185
Carrots	...	88.6	11.4	1.1	.4	8.9	1	200
Onions	...	87.6	12.4	1.4	.3	10.1	.6	225
String beans	...	87.2	12.8	2.2	.4	9.4	.8	235
Green peas	...	78.1	21.9	4.4	.6	16	.9	405
Green corn	...	81.3	18.7	2.8	1.1	13.2	.6	345
Tomatoes	...	96	4	.8	.4	2.5	.3	80
Cabbage	...	91.9	8.1	2.1	.3	5.5	1.1	155
Apples	...	83.2	16.8	.2	.4	15.9	.3	315
Sugar, granulated	...	2	98	...	...	97.8	.2	1,820
Molasses	...	24.6	75.4	...	...	73.1	2.3	1,360
White bread (wheat)	...	32.3	67.7	8.8	1.7	56.3	.9	1,280
Boston crackers	...	8.3	91.7	10.7	9.9	68.7	2.4	1,895

Table B.—*Amounts of nutrients furnished for 25 cents in food materials at ordinary prices.*

Food materials as purchased.	Prices per pound.	Twenty-five cents will pay for— Total food materials.	Nutrients. Total.	Nutrients. Protein.	Nutrients. Fats.	Nutrients. Carbohydrates.	Fuel value.
	Cents.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Beef, sirloin	10	2.50	.79	.38	.41	....	2,425
Do	15	1.67	.52	.25	.27	....	1,620
Do	20	1.25	.39	.19	.20	....	1,215
Do	25	1	.31	.15	.16	....	970
Beef, round	8	3.13	.95	.56	.39	....	2,675
Do	12	2.08	.63	.37	.26	....	1,780
Do	16	1.56	.47	.28	.19	....	1,335
Beef, neck	4	6.25	1.85	.98	.87	....	5,500
Do	6	4.17	1.23	.65	.58	....	3,670
Do	8	3.13	.93	.49	.44	....	2,755
Mutton, leg	8	3.13	.96	.47	.49	....	2,925
Do	14	1.79	.55	.27	.28	....	1,675
Do	20	1.25	.38	.19	.19	....	1,170
Ham, smoked	10	2.50	1.23	.37	.86	....	4,340
Do	16	1.56	.77	.23	.54	....	2,705
Salt pork	10	2.50	2.09	.02	2.07	....	8,775
Do	14	1.79	1.50	.02	1.48	....	6,285
Do	18	1.39	1.16	.01	1.15	....	4,880
Codfish, fresh	6	4.17	.45	.44	.01	....	855
Do	10	2.50	.27	.27	....	....	510
Codfish, dried salt	6	4.17	.68	.67	.01	....	1,315
Do	8	3.13	.51	.50	.01	....	985
Mackerel, salt	10	2.50	.74	.37	.37	....	2,275
Do	15	1.67	.49	.24	.25	....	1,520
Oysters, 25 cents per quart	12.5	2	.24	.13	.03	.08	520
Oysters, 35 cents per quart	17.5	1.43	.17	.09	.02	.06	370
Oysters, 50 cents per quart	25	1	.12	.06	.02	.04	260
Eggs, 15 cents per dozen	8.8	2.84	.63	.34	.29	....	1,860
Eggs, 25 cents per dozen	14.7	1.70	.38	.21	.17	....	1,115
Eggs, 35 cents per dozen	20.6	1.21	.27	.15	.12	....	790
Milk, 3 cents per quart	1.5	16.67	2.05	.60	.67	.78	5,420
Milk, 6 cents per quart	3	8.33	1.02	.30	.23	.39	2,705
Milk, 8 cents per quart	4	6.25	.77	.23	.25	.29	2,030
Cheese, whole milk	12	2.08	1.36	.59	.74	.03	4,305
Do	15	1.67	1.09	.47	.59	.03	3,455
Do	18	1.39	.91	.39	.49	.03	2,875
Cheese, skim milk	6	4.17	2.25	1.60	.28	.37	4,860
Do	8	3.13	1.69	1.20	.21	.28	3,645
Do	10	2.50	1.35	.96	.17	.22	2,910
Butter	15	1.67	1.45	.02	1.42	.01	6,035
Do	25	1	.86	.01	.85	....	3,615
Do	35	.71	.61	.01	.60	....	2,565
Sugar	5	5	4.89	....	....	4.89	9,100
Do	7	3.57	3.50	....	....	3.50	6,495
Wheat flour	2	12.50	10.87	1.37	.14	9.36	20,565
Do	2.5	10	8.70	1.10	.11	7.49	16,450
Do	3	8.33	7.24	.91	.09	6.24	13,705
Wheat bread	3	8.33	5.56	.73	.14	4.69	10,660
Do	5	5	3.34	.44	.08	2.82	6,400
Do	8	3.13	2.09	.28	.05	1.76	4,005
Corn meal	2	12.50	10.45	1.15	.47	8.83	20,565
Do	3	8.33	6.97	.77	.32	5.88	13,705
Oatmeal	3	8.33	7.51	1.22	.59	5.70	15,370
Do	5	5	4.52	.74	.36	3.42	9,225
Rice	6	4.17	3.64	.31	.02	3.31	6,795
Do	8	3.13	2.73	.23	.01	2.49	5,100
Beans	5	5	4.22	1.16	.10	2.96	8,075
Potatoes, 45 cents per bushel	0.75	33.33	5.70	.60	.03	5.07	10,665
Potatoes, 60 cents per bushel	1	25	4.27	.45	.02	3.80	8,000
Potatoes, 90 cents per bushel	1.5	16.67	2.85	.30	.02	2.53	5,335

DIETARY STANDARDS.

	Nutrients. Total.	Nutrients. Protein.	Nutrients. Fats.	Nutrients. Carbohydrates.	Fuel value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Man with light exercise	1.32	.22	.22	.88	2,980
Man with moderate muscular work	1.55	.28	.28	.99	3,520
Man at active muscular work	1.76	.33	.33	1.10	4,060

TABLE C.—*Prices used in estimating cost of daily dietaries.*

Articles.	Price per pound.	Articles.	Price per pound.	Articles.	Price per pound.
Beef:	*Cents.*	Pork—Continued.	*Cents.*		*Cents.*
Neck	7	Ham	16	Cheese	16
Chuck	10	Salt pork	12	Potatoes, white	1¼
Shoulder	12	Sausage	12	Sweet potatoes	2
Sirloin	20	Fish:		Turnips	2
Rump	16	Mackerel	12	Sugar	5
Round	14	Whole cod	8	Beans	5
Liver	10	Dry salt cod	7	Corn meal	2½
Dried beef	25	Salt mackerel	12	Oatmeal	5
Mutton:		Canned salmon	15	Wheat flour	2½
Shoulder	12	Lobster	12	Graham flour	3
Leg	18	Eggs, 24 cents per dozen	14	Wheat bread	4
Loin	20	Milk, 7 cents per quart	3½	Rice	7
Pork:		Butter	30	Canned corn	16
Loin	16				

TABLE D.—*Daily dietaries—Food materials furnishing approximately the 0.28 pound of protein and 3,500 calories of energy of the standard for daily dietary of a man at moderate muscular work.—Cost estimated from prices given in Table C.*

Food materials.	Amount.	Cost.	Nutrients.				Fuel value.
			Total.	Protein.	Fats.	Carbohydrates.	
I.	*Ounces.*	*Cents.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
Beef, round steak	13	11.40	.26	.14	.12		695
Butter	3	5.65	.16		.16		680
Potatoes	6	1.25	.17	.02		.15	320
Bread	22	5.50	.89	.12	.02	.75	1,760
	44	23.80	1.48	.28	.30	.90	3,455
II.							
Pork, salt	4	3	.21		.21		880
Butter	2	3.75	.11		.11		450
Beans	16	5	.84	.23	.02	.59	1,615
Bread	8	2	.33	.04	.01	.28	640
	30	13.75	1.49	.27	.35	.87	3,585
III.							
Beef, liver	9	5.65	.17	.12	.03	.02	375
Butter	3	5.65	.16		.16		780
Milk, ½ pint	8	1.75	.06	.02	.02	.02	165
Corn meal	12	1.85	.63	.07	.03	.53	1,230
Bread	12	3	.50	.07	.01	.42	965
	44	17.90	1.52	.28	.25	.99	3,515
IV.							
Beef, sirloin steak	12	15	.25	.12	.13		725
Butter	3	5.65	.16		.16		680
Milk, 1¾ pints	28	6.15	.22	.06	.08	.08	570
Potatoes	12	.95	.12	.01		.11	240
Flour	12	1.85	.65	.08	.01	.56	1,235
	67	29.60	1.40	.27	.38	.75	3,450
V.							
Ham	12	12	.37	.11	.26		1,300
Pork, salt	⅓	.35	.03		.03		110
Butter	1	1.90	.05		.05		225
Potatoes	8	.65	.09	.01		.08	160
Beans	5	1.55	.27	.07	.01	.19	505
Flour	12	1.85	.65	.08	.01	.56	1,235
	38⅓	18.30	1.46	.27	.36	.83	3,535
VI.							
Beef, neck	10	4.40	.19	.10	.09		550
Butter	1	1.90	.05		.05		225
Milk, 1 pint	16	3.50	.13	.04	.04	.05	325
Potatoes	16	1.25	.17	.02		.15	320
Oatmeal	4	1.25	.23	.04	.02	.17	460
Bread	16	4	.67	.09	.02	.56	1,280
[illegible]ar	3	.95	.19			.19	345
	66	17.25	1.63	.29	.22	1.12	3,505

TABLE D.—*Daily dietaries—Food materials furnishing approximately the 0.28 pound of protein and 3,500 calories of energy, etc.*—Continued.

Food materials.	Amount.	Cost.	Nutrients. Total.	Protein.	Fats.	Carbohydrates.	Fuel value.
	Ounces.	*Cents.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Calories.*
VII.							
Beef, shoulder	8	6	.16	.09	.07	...	450
Salmon, canned	4	3.75	.10	.05	.05	...	245
Butter	2½	4.70	.13	...	.13	...	565
Milk, 1½ pints	24	5.25	.18	.05	.06	.07	485
Potatoes	8	.65	.09	.01	...	.08	160
Oatmeal	2	.65	.11	.02	.01	.08	230
Flour	10	1.55	.55	.07	.01	.47	1,030
Sugar	3	.95	.19	...	...	.19	345
	61½	23.50	1.51	.29	.33	.89	3,510
VIII.							
Beef, chuck	10	6.25	.22	.09	.13	...	800
Ham	6	6	.19	.06	.13	...	650
Two eggs	3	4	.05	.03	.02	...	135
Butter	2	3.75	.11	...	.11	...	450
Milk, 1 pint	16	3.50	.13	.04	.04	.05	325
Potatoes	12	.95	.12	.01	...	.11	240
Flour	8	1.25	.44	.05	.01	.38	825
Sugar	1	.30	.06	...	...	.06	115
	58	26	1.32	.28	.44	.60	3,540
IX.							
Beef, sirloin steak	8	10	.17	.08	.09	...	485
Mutton chops	5	6.25	.14	.04	.10	...	465
Butter	2	3.75	.11	...	.11	...	450
Milk, 1½ pints	24	5.25	.18	.05	.06	.07	485
Potatoes	8	.65	.09	.01	...	.08	160
Oatmeal	3	.95	.17	.03	.01	.13	345
Bread	12	3	.50	.07	.01	.42	965
Sugar	2	.65	.12	...	...	.12	230
	64	30.50	1.48	.28	.38	.82	3,585
X.							
Beef, neck	12	5.25	.22	.12	.10	...	660
Lobster	8	6	.03	.03	...	...	65
Butter	3	5.65	.16	...	.16	...	680
Milk, 1 pint	16	3.50	.12	.03	.04	.05	325
Potatoes	8	.65	.09	.01	...	.08	160
Oatmeal	2	.65	.12	.02	.01	.09	230
Bread	12	3	.50	.07	.01	.42	960
Sugar	4	1.25	.25	...	...	.25	460
	65	25.95	1.49	.28	.32	.89	3,540
XI.							
Beef, dried	3	4.70	.06	.05	.01	...	140
Mutton leg	10	11.25	.19	.09	.10	...	580
1 egg	1½	2	.02	.01	.01	...	70
Butter	3	5.65	.16	...	.16	...	680
Milk, ¾ pint	12	2.65	.09	.02	.03	.04	245
Potatoes	8	.65	.09	.01	...	.08	160
Oatmeal	3	.95	.17	.03	.01	.13	345
Bread	10	2.50	.42	.06	.01	.35	800
Sugar	4	1.25	.25	...	...	.25	460
	54½	31.60	1.45	.27	.33	.85	3,480
XII.							
Beef, round steak	8	7	.16	.09	.07	...	425
Cod, dried	2	.90	.03	.03	...	...	40
1 egg	1½	2.00	.02	.01	.01	...	70
Butter	3	5.65	.16	...	.16	...	680
Milk, 1¼ pints	20	4.40	.15	.04	.05	.06	405
Potatoes	8	.65	.09	.01	...	.08	160
Oatmeal	2	.65	.12	.02	.01	.09	230
Flour	10	1.55	.55	.07	.01	.47	1,030
Sugar	4	1.25	.25	...	...	.25	460
	58½	24.05	1.53	.27	.31	.95	3,500
XIII.							
Sausage	4	3	.14	.03	.11	...	510
Cod, whole	14	7	.07	.07	...	...	140
Butter	2	3.75	.11	...	.11	...	450
Milk, 1 pint	16	3.50	.13	.04	.04	.05	325
Beans	5	1.55	.26	.07	.01	.18	50[illegible]
Rice	2	.90	.11	.01	...	.10	
Sweet potatoes	16	2	.24	.01	...	.23	
Bread	8	2	.33	.04	.01	.28	
Sugar	3	.95	.19	...	...		
	70	24.65	1.58	.27	.28		