

does not help us. The fuel value of wood is high, too, but although some animals can use wood for fuel in their bodies, we humans can't, so the fuel value of wood is no use to us. So also with grass and hay. Cows and horses can use those, but we can't. We have to find out by experience what things we can eat first, but once we know that, then knowing the fuel values of these different things also allows us to compare them pretty well. It must not be supposed that fuel value is the whole thing, however. Certain foods, especially vegetables, contain substances in very small amounts, a dram or less to the ton, which cut no figure at all as fuel, yet are so important to the body that disease and death result if they are not present. These are called vitamins. Their absence results in a disease called beri-beri, and scurvy is probably due to a similar lack.

Finally, as stated in a previous article, the fuel value of fat is more than double that of either of the other great foods, carbohydrate and protein,

#### DAILY FOOD FUEL REQUIRED BY AN ADULT MAN.

	grams	ounces	would boil water	calories
Protein	125 grams	= 4.4 oz.	= 5 quarts	= 512.5
Fat	75 grams	= 2.6 oz.	= 7 quarts	= 697.5
Carbohydrate	500 grams	= 17.6 oz.	= 20.5 quarts	= 2050.0
	<u>700</u>	<u>24.6</u>	<u>32.5</u>	<u>3260.0</u>

but we would die in time on a diet of fat alone—so also on a diet of carbohydrate alone. Protein\* would keep life in us, all alone, but we would not get on as well as on a mixed diet.

#### CALCULATING FUEL VALUES.

As previously explained, many of the different animal and vegetable foods that we eat, contain, in a crude state, some two or all three of the main things, protein, fat, carbohydrate; and they contain them in different proportions. Instead of laboriously testing the fuel value of every individual food, it is much easier and better to know the fuel value of protein, of fat, and of carbohydrate. Then we can, by simply analyzing the food, calculate the fuel value without further trouble.

Heat enough to raise the temperature of one litre of water one degree centigrade, is called a calorie. About one pound of protein, completely burned, would yield heat enough in burning to boil about four and a half gallons of water (about three and a half imperial gallons) that was just at the freezing

point when the heat was first applied to it. (In actual tests, protein burned yields more heat than this, but in the body it is not all used for fuel, but partly to replace worn-out tissues, so that in the body it produces the heat above described.)

Carbohydrates have the same heat value in the body that the proteins have; but the fats have over twice the heat value, i. e., would boil twice as much water; a pound of lard, for instance, completely burned, would bring to boil about ten gallons of freezing water (about eight imperial gallons).

Now, the body requires varying amounts of fuel, depending on age, sex, height, weight, amount of work done, and many other things. Thus a young infant needs perhaps an average of 100 calories a day, i. e., enough food-fuel heat to bring to boil a quart of freezing-cold water. An active adult man, doing hard, muscular work, will need from 3,000 to 4,000 calories, or even more—enough to bring to boil eight or ten gallons of freezing-cold water.

Now, theoretically, a man could get the 3,000 to 4,000 calories he needs from a pound of lard, but fancy feeding a man a pound of lard a day, and nothing else! Moreover, he would starve to death on it, despite its fuel value, for pure lard contains no protein, i. e., no muscle or other tissue builder. Theoretically, also, a man would get the heat he needed from about two and a quarter pounds of granulated sugar, but again he would soon give out for lack of protein, even if he could manage to "down" pure sugar three times a day as his only food. Theoretically, also, two and a quarter pounds of protein would do him, with nothing else.

It is true he would not starve to death on this, but he would miss the quick-burning fats and sugars, and would not "feel right" or healthy or happy. The proportions of each form of food, then, is important. One might say, if we need all three kinds, why not just divide the total calories we need by three, and eat protein enough to supply one-third, fat enough to supply one-third, and carbohydrates enough to supply one-third? Doubtless this would make a tolerable diet, but experience and experiment go to show that an average adult man doing reasonably hard work, gets along

\*The protein of maize is an exception. It lacks certain constituents that other proteins have.