LABORATORY

OF THE

INLAND REVENUE DEPARTMENT

OTTAWA, CANADA.

BULLETIN No 377

HUMAN FOOD

CONSIDERED IN ITS RELATION TO QUANTITY AND COST.

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CONSIDERED IN ITS RELATION TO QUANTITY AND COST.

OTTAWA, June 12th, 1917

J. U. VINCENT, ESQ., K. C., B. A., L. Ph.

DEPUTY MINISTER OF INLAND REVENUE.

DEAR SIR,

You have been good enough to propose publication of the accompanying paper as one of our Departmental Bulletin series; and it is necessary to explain that it was originally written for other use, in order to account for certain peculiarities in phraseology and style. I hope that it may serve to popularize the fundamental principles which govern the intelligent use of food materials. My experience proves that great ignorance and much misconception exist on the part of the public, due to a belief that the whole subject of nutrition is hopelessly complex and must be left to the expert. If I have been able to present some phases of the matter in plain and easily understood language, and to suggest practical application of certain basic principles, I shall be gratified.

Yours very truly,

A. McGILL,

Chief Analyst.

It is pleasing to know that there exists a large class of Canadians of sufficient means to choose their food without regard to its market cost. Their selections are guided solely by considerations of palatability, nutritiveness and fashion, which generally means strawberries in winter, and unseasonableness throughout the year. It is not for people of this class that I am writing.

A very much larger class of our people is compelled, in these days of high prices, to consider somewhat closely the cost of food; and perhaps the largest class of all finds it necessary to reduce expenditure in matters of education, clothing and amusements in order to pay the grocer's and butcher's bills.

It may seem audacious in me to say that I am convinced that a very little elementary knowledge of well ascertained facts concerning the meaning of nutrition, and the actual utilization of food in the maintenance of life, might reduce the cost of our food fully fifty per cent, without any sacrifice of physical wellbeing. I have, however, given this matter very careful study, and I do not hesitate to make the above statement, quite deliberately.

Where then lies the difficulty in effecting this economy? Just here, that in order to practical results, the modicum of knowledge above referred to must be possessed not by the university professor, or even by the student, but by the average housewife, to whom is entrusted the marketing and the cooking of our food.

This brief essay is therefore addressed to the housewife, and is intended to be perfectly comprehensible by those who have had no formal or academic training in chemistry or biology, or any other of the sciences with whose results it deals. As far as possible, I shall avoid the use of unfamiliar terms; and if exactness of statement must thereby suffer, I shall nevertheless assure the reader of a sufficient degree of accuracy to justify her confidence, and to ensure useful results.

SOME PRELIMINARY CONSIDERATIONS.

One man lives essentially on bread and milk, another on meat, potatoes and water. Both are healthy and apparently well nourished. We look at these men, examine them carefully, and find that, so far as we can judge, they are made of the same stuff. Had we no other source of information than our own observation we should find it impossible to say which man was made of bread and milk, and which of meat and potatoes. Even when subjected to the most thorough medical inspection, it is found that flesh, bone, blood, skin, cartilage, secretion and all other detail, are essentially alike in each.

Here surely is food for thought; and it ought to be perfectly evident that the food eaten by each, however different in name and in appearance, must have some common character; it is in each case, capable of transmutation into body material. And the special foods named are only particular cases of scores of purchasable foods which could have effectively replaced them.

It must be sufficiently evident that, leaving out of account those foods which we eat, not because we need them, but simply for the pleasure of eating, food is needed for two main purposes — first, to build up the material of the body and to replace tissue which is wasted in life processes; second, to furnish energy, or the power to do work. For the human body is a machine in action; and like any other machine, must undergo constant repair, and be furnished with some motive power, in amount proportioned to the work it is required to perform. This power to do work, we call *energy*; and in order that we may speak definitely about energy we must have some unit of measurement of energy. When we want to speak of distance, we say so many miles; or of weight, so many pounds. In the case of energy, we use the *calorie* as our unit. It is not at all necessary to know that a calorie is the equivalent of an amount of energy, in the form of heat, that is required to raise the temperature of 1 litre of water through 1 degree Centigrade. It makes our thinking all the more definite to know this, as it does to know that a pound is 7000 grains; or that it is the force of gravity at a certain latitude, acting upon a mass of platinum carefully preserved in the archives at Westminster. But such exact knowledge is quite unnecessary for our purposes. If I am travelling in Russia, where they measure distance in versts, and I am told that my rate of travelling is, 30 versts per hour and my destination is 300 versts distant, I can just as well calculate the time at which I shall reach home, as I would do if I knew what a verst actually was in yards or miles. Fix in your mind the term *calorie* as a measure of energy; and don't bother about its complete significance.

But remember that a man of 156 lbs. weight, lying quietly in bed all day, requires to be supplied with 1848 calories of energy if at the end of the day he is to be as well and strong as he was in the morning. If he sits up in a chair, all day, he will require 1996 calories of energy, because the sitting posture demands more muscular effort ; and if he moves about the house, or is at all fidgety, he must have 2160 calories. A hospital patient of 156 lbs. weight, must have more than this if he is to grow stronger, for the numbers given do not allow of added vitality, but merely the maintenance of initial vitality. If our man is to do any kind of work, he must of course, be supplied with additional calories of energy ; and Rubner, the great German authority on this subject finds an average of 2445 calories requisite for such men as writers, draughtsmen, tailors, physicians, etc.

Actual computations of the diet of Farmers, maintained in good health show the following :—

Farmers in	Connecticut	3410	calories
"	Vermont	3635	"
"	New-York	3785	"
"	Mexico	3435	"
"	Italy	3565	"
"	Finland	3474	"
	Average	3551	"

(*Lusk.* Fundamental Basis of Nutrition.)

Lusk says : From the present available data one may estimate the daily energy requirement of a well-nourished adult (156 lbs) as follows :

Occupation		
In bed 24 hours	1680	calories
In bed 8 hours, work involving sitting in a chair 16 hours	2170	"
Bed 8 hours, in a chair 14 hours, moderate exercise 2 hours	2500	"
Farmers	3500	"
Rider in a 6 day bicycle race	10000	"

I want to impress upon you the importance of thinking in terms of *calories* when you are dealing with what we call vital energy. When you ask your friend "How do you do, to-day?" you are really asking him whether the energy that he expends in his daily life work is satisfactorily replaced by the energy that he derives from his food. If this is not the case, then he is starving.

Starvation. Every human body, in a good state of health, represents a certain fixed income and outgo of energy, which we call the normal. If excess of food, more than requisite to maintain this *normal* is supplied, one or more of several things must happen. (1) The excess food may pass through the body unchanged or practically so—in which case waste occurs, and worse than waste; for a certain amount of energy must be expended to carry this overplus through the body ; (2) The excess food may be digested and assimilated (metabolized) and what we call *growth* results. The body becomes bigger and heavier, and, if this growth be normal, as in the case of children and young people, all is well. (3) The excess food may be changed into fat, and more or less fat may be deposited in the tissues. Up to a certain point this is a good thing. The fat represents a storage of energy (potential energy) that may serve a good purpose on occasion; just as a bank deposit, representing money of which you have no need at the moment, may come to be useful, when your debtors don't come to time, and enable you to meet your obligations. But this deposition of fat may go to excess; and by creating layers of fat in the muscles, may so weaken them, that they can no longer work efficiently. For example; the heart is a muscle, and what is called fatty degeneration of the heart, always fatal, is merely the result of too much fat deposition in this muscle.

If too little food be taken, then, as long as expenditure of energy goes on and it has already been shown that an expenditure amounting to 1680 calories, in the case of an adult of 156 lbs. weight goes on in every 24 hours, even though the person lies quietly in bed the whole time, there must be a deficit at the end of each day, and the individual undergoes starvation. If he possesses a considerable store of surplus energy, as fat, this store will be drawn upon. The body will lose weight, but the loss is something that can be spared without serious harm. When this store of fat is used up, energy can still be obtained, but it will now be derived from the actual body tissue and the body will waste away to the point of exhaustion and death. This is of course, the worst kind of cannibalism for the man is consuming, as food, the material of his own body. Death results when the weight of the body is reduced to two-fifths of its original weight (Chossat). This, of course, refers to death by simple starvation, and apart from all disease.

All foods provide energy. A substance taken by the mouth, which does not furnish energy, is not, in the true sense, a food. We do, as a matter of fact, take in many such substances with our food, chiefly for the purpose of sweettening it (saccharin) or of giving it a pleasant flavour. (spices, etc). One substance, which is not in the strict sense a food, we must have in considerable amount. I refer to water. Sixty-three per cent. of the total weight of the human body consists of water. Practically all foods as prepared for the table, consist largely of water. This is especially the case with soups stews, puddings, porridge, etc., and many market food stuffs, which we do not think of as containing water, nevertheless contain large amounts of it. Thus, average beef contains 15 per cent; fresh fish about 30 to 40 per cent ; bread 33 per cent; potatoes 76 per cent ; cabbage 90 per cent.

But water must be taken to a greater or less extent by itself, in addition to that which is incorporated with our ordinary table dishes. We must keep in mind that most of the waste products of life (chlorides, urea, uric acid, phosphates, etc.) are got rid of by the use of water as a solvent.

Fortunately, the consumption of water does not enter largely into the question of the cost of food, so that I need say nothing further about it than that we are not likely to use too much of it as a beverage, while most people use decidedly too little.

All foods, properly so called, may be divided into two classes :—

1st. Those which contain material capable of building up the tissues of the body (muscle, bone, cartilage, etc.) in addition to being able to furnish energy. To this class of foods the term *proteids* is applied.

2nd Those foods which, practically, supply energy only. It is necessary on account of the way in which the body works in changing food into energy, to subdivide this class into two subclasses, known as *Fats* and *Carbohydrates*.

Fats and Carbohydrates are capable, to some extent, of replacing each other without serious impairment of the bodily functions; but neither sub-class can totally replace the other without disastrous results.

These three terms proteids, fats, carbohydrates must be constantly borne in mind, if any useful application of scientific knowledge is to result. Some examples of typical foods of each class may be given to assist in memorizing the terms.

Proteids. The white of egg, skim-milk cheese and gelatin are illustrations of food material essentially of proteid character. Among foods which do not altogether consist of proteids, but are chiefly valued because of their proteid content may be mentioned all kinds of meat and fish; gluten bread, condensed skim milk, macaroni.

All proteids are not of equal value in nutrition, but although the differences are considerable, it would be entirely beyond the scope of this paper to enter into details.

What is of prime importance to be remembered is the fact that on an average, every ounce of proteid is capable of producing 116 calories of energy, when digested and assimilated as food. (calculated from 1 gramme = 4.1 calories). This number will be frequently made use of in what follows, and should be remembered.

Fats. This term is quite generally understood, and must be taken to include all fats of whatever origin. For although small differences exist between the food values of fats derived from animal sources (butter, lard, tallow, etc.) and those of vegetable origin (olive oil, cocoanut oil, cotton seed oil, etc.) these differences are so small as to be negligible for purposes of this study.

Every ounce of fat, properly digested in the body, produces 264 calories of energy, and this number must be fixed in the memory.

Carbohydrates. This term includes the various starches (wheat, rice, potato, oatmeal, etc.) and also sugars (ordinary sugar, syrup, honey, etc.)

The energy value of carbohydrates is identical with that for proteids, namely 116 calories per ounce; but carbohydrates, unlike proteids, do not contain material for building up the framework of the body.

I have already pointed out that life processes demand expenditure of energy and that, if these processes are to be continuous, there must be a continuous supply of energy, by means of food.

For a man of average weight, engaged in ordinary work largely sedentary during 10 hours of every day, it has been shown that a daily expenditure of energy measured as 2500 calories is involved; while for a man engaged in arduous work (such as farming) 3500 calories are needed.

For a woman, it has been established that approximately four-fifths of the above amounts of energy are expended.

But it is not enough to know the total energy as must be evident by considering that fats and carbohydrates while supplying large amounts of energy, do not supply the body-building elements. If the framework of the machine is not kept in repair, it cannot be expected to do its work no matter how much power is supplied to it. Indeed, the more energetically we insist on driving a machine, any of whose parts are out of adjustment, the sooner shall we wreck it altogether.

This phase of the matter has also been studied very carefully by physiologists; and perfectly definite results are on record. The most important generalization is that of Professor Voit, who is recognized as the highest authority upon this subject. According to Voit, the daily diet of a man engaged in work requiring an expenditure of 2810 calories of energy, should be in the ratio :

Proteids : Fat : Carbohydrates : = 4.162: 1.975: 17.637, and for a woman requiring 2240 calories, the ratio should be :

Proteids : Fat, Carbohydrates : =3.316: 1.587: 14.110.

These ratios represent parts by weight, and are intended to apply to the food of persons who must economize in expenditure to the lowest limit at which health can be maintained.

It will be noted that the amount of fat is in each case about one-ninth of the amount of carbohydrate. This is acknowledged to be undesirably low; and is suggested with a view to the utmost economy, fat being the most costly food constituent. The lower classes of the German peasantry use a diet of the kind indicated. Among the wealthy classes of Germany however, the ratio of fat to carbohydrate was found to be 1 to 3 or 4 instead of 1 to 9. I have already stated that while fats and carbohydrates cannot replace proteids in the diet, they may to a large extent, replace each other. Where utmost economy is necessary, of course the fat component of the diet, as being the most costly, will be reduced to its lowest terms, and the carbohydrate correspondingly increased. There is a limit below which this cannot be done, if health is to be maintained, and the above quoted ratio fixes this limit. It is regrettable that food fat in palatable form, should be so costly. Wherever possible the fat should be increased, and the carbohydrate correspondingly decreased.

It is notoriously the case that the greater part of the fat in lamb and mutton chops, sirloin steak, and the best cuts of all kinds of meat, is not eaten, and is too often wasted. The butcher leaves this fat on the chop or steak, partly as evidence that the meat is derived from a well fatted carcase, and partly because he gets a better price for it, when sold at the price of chops or steak, than he could secure by selling it simply as fat. The ordinary man has no appetite for the excess of beef or mutton fat supplied in the form of cooked steak or chop. Here is a distinct waste of valuable food material, a waste which amounts to millions of dollars every year. This excess of beef and mutton fat should be worked up into palatable form, a matter which could be easily accomplished by well known methods of manufacture.

This aspect of the matter is so very interesting that I am tempted to introduce some statistics, by way of illustration. The following represent actual dietaries upon which the individuals, representative of the classes to which they respectively belong, maintained a working vitality. They are quoted from Hammarsten's Physiological Chemistry, as translated by Mandel; and are not be to understood as other than selected instances of actually investigated cases, introduced for illustrative purposes. I have merely converted Hammarsten's statements, which are given in grammes, into ounces in order that they may be more intelligible to my readers.

Examples of the daily quantity of food in specific individuals and the calculated energy represented by this food.

Quantities in ounces Avoirdupois. *Energy* in calories.

	Description	Proteids	Fats	Carbohydrates	Calories
1	Soldier during peace	4.197	1.411	18.659	2784
2	Soldier in light service	4.127	1.235	15.768	2424
3	Soldier in the field	5.150	1.623	17.778	2852
4	Labourer at work	4.586	1.411	19.400	2903
5	Labourer at rest	4.832	2.540	12.416	2458
6	Cabinet maker (40 years)	4.621	2.398	17.425	2835
7	Young physician	4.480	3.171	10.143	2602
8	Young physician	4.727	3.598	10.300	2476
9	Labourer	4.691	3.351	14.885	2902
10	English smith	6.208	2.505	23.492	3780
11	English pugilist	10.159	3.104	3.280	2189
12	Bavarian woodman	4.762	7.337	30.900	5589
13	Silesian labourer	2.822	0.564	19.471	2518
14	Seamstress in London	1.904	1.023	10.300	1688
15	Swedish labourer	4.727	2.787	17.108	3019
16	Japanese student	2.928	0.494	21.941	2779
17	Japanese shopman	1.940	0.212	13.898	1744
18	Eskimo (Krough)	9.947	1.443	1.792	2604
19	Bengali	1.834	0.907	16.649	2390

A little intelligent attention given to this record will be well repaid; and I would particularly ask you to note the following points.

Nos. 1, 2, 3. The soldier in the field receives a decidedly better ration than in peace, or on light service. The increase is most notable in proteid and fat; but whether in barracks or in the field his ration is adequate; and is practically that recommended by Voit for a man of about 150 to 160 pounds weight. The proportions of each constituent are approximately correct, with exception of the fat, which is distinctly too low. This is undoubtedly a matter of economy and cannot be scientifically justified.

Nos. 4 and 5. It should be understood that the weight of the body must be taken into account in all computations of a proper ration. I have not the body weight of the individual here reported. He has more fat when at rest than when at work, which is distinctly not as it should be. Probably when on holiday, he is able to indulge in butter to an unusual extent. His excess energy demanded by labour is derived from increased carbohydrates, the cheapest source of energy.

No. 6. Is fairly well nourished.

Nos. 7 and 8. Professional work does not make such strenuous demands for expenditure of energy. It is usually better paid; hence the possibility of supplying a larger proportion of it by the consumption of relatively expensive fats.

No. 9 This labourer is better nourished than No. 4, although the energy furnished by his food is identical with that of No. 4. A much larger proportion of it is supplied by fat.

No. 10. It is evidently a big man, expending much energy. The proportion of fat in his diet is decidedly too small.

No. 11. The pugilist in training is putting on muscle. He is supplied with large excess proteid matter, and carbohydrates are kept down as much as possible. This is not a normal ration, but one suited to a special end.

No. 12. Is amply supplied with energy for very severe work. Such a ration could not be tolerated by any other than a strong man, very actively employed.

No. 13. Evidence of poverty is given by the reduction of fat in his ration.

No. 14. A clear case of under nutrition. One is reminded of the "Song of the Shirt".

No. 15. A good ration, for light work.

No. 16. Diet chiefly rice, and sadly lacking in fat.

No. 17. Emphatically under nourished. It must however be remembered that Nos. 16 and 17 are probably cases of very small men.

No. 18. Great excess of proteids as compared with the other food components. It must, however, be kept in mind that climatic and food conditions are not comparable in the case of the eskimo, with those obtaining in temperate climes.

No. 19. As contrasted with No. 18, the difference between life in Hindostan and Greenland is very evident.

APPLICATION

If what has been said is clearly apprehended, it remains but to emphasize the fact that the lowest satisfactory ration for the average man, engaged in ordinary work, must contain about 2800 calories of energy, and for a woman about 2240 calories; and that this amount of energy should be supplied by proteids, fat and carbohydrate food, in the ratio of 4.162 ounces, 1.975 ounces and 17.637 ounces, respectively, in the daily diet of man; and 3,316 ounces, 1.587 ounces and 14.110 ounces for women.

A better diet, for those who can afford it, results from an increase in the fat content, and a corresponding decrease in the carbohydrate content.

These are rather awkward numbers to bear in mind, and it is not necessary in actual life, that we should work so close to theory. Especially is this the case when we remember that complete utilization of the food eaten, seldom or never occurs; nor can we expect every sample of any one kind of food to be strictly similar to every other. The average values of all ordinary food materials, stated as proteids fat and carbohydrates, have been very carefully determined. Full milk cheese, for example, as calculated from the examination of very numerous samples, contains 23 per cent. proteids, 27 per cent, fat and 4 per cent, carbohydrates; while skim milk cheese contains 33.4 per cent, proteids, 6.6 per cent, fat, and 5 per cent, carbohydrates, the difference in each case, being made up of mineral matters and water, which we do not recognize as food for our present purpose. But individual samples of cheese will vary from these averages by amounts that remain unknown to the consumer. The same thing is true of meats, fish, breads, and all other forms of food.

The individual variations must, for our purpose be left out of consideration in constructing a ration and we must agree to accept the best available averages as our guides. If we buy only honest and unadulterated food, we may feel reasonably sure that its energy equivalent will not depart very largely from the values given in the following table. Remembering what has been said, it will be sufficient to take the following ratios, as defining the rations indicated.

Cheapest satisfactory daily ration.

For man, of average weight (150-160 lbs).

Proteids, 4.2 oz : Fats 2 oz: Carbohydrates 18 oz. energy equivalent = 2903 calories.

For woman of average weight :

Proteids 3.5 oz: Fats 1.6 oz: Carbohydrates 14 oz. energy equivalent = 2452 calories.

A better ration would be :

For man, Proteids 4.2 oz: Fats 3 oz: Carbohydrates 16 oz., energy equivalent = 3135 calories.

For woman Proteid 3.5 oz: Fats 2 oz: Carbohydrates 15 oz. energy equivalent = 2674 calories.

If now we know the proteid, fat and carbohydrate value of every market-food, we can, with a good degree of exactness calculate the amounts of the various foods needed to furnish any desired ration ; and if in addition to this, we know the market prices of the different materials, we are able, by very simple calculations, to determine the cost of such ration; and to vary its cost according to changes in market prices, without changing the food value of the ration, that is its energy producing value, which is the main consideration in the case of most of us.

A few examples will suffice to indicate the process.

Each *one pound avoirdupois* of the following foods, contains the stated number of *ounces* of proteids, fats and carbohydrates respectively.

The numbers given have been re-calculated from the percentage numbers tabulated by Kœnig in his great work "Chemie der Menschlichen Nahrungs und Genussmittel" 4th Edition.

In most cases they are averages from great numbers of analytical determinations; and although individual specimens of any particular food may vary considerably, from these averages, we may confidently accept them as representing the true food content, when more than one or two purchases are taken into account.

Each 1 lb. avoirdupois of the food named contains	Proteids ounces	Fats ounces	Carbo-hydrates ounces	Cost of 1 lb Ottawa June 1917	Remarks
Beef —Brisket	3.056	1.996	0	.16	Best
" flank	2.768	4.128	0	16 to 12.5	1st & 2nd cuts.
" loin	2.928	3.120	0	.35	
" sirloin	3.024	2.832	0	.35	
" tenderloin	2.496	3.904	0	.75	
" ribs	2.736	4.080	0	.28	
" roundsteak, best	3.264	1.600	0	.32	
" roundsteak second	2.816	3.808	0	.25	
" foreshank	3.280	1.440	0	.10	
" hindshank	3.248	1.520	0	.10	
" tongue	2.784	2.880	0	.25	
" heart	3.088	2.128	0	.12.5	
" liver	3.216	0.880	0	.15	
" kidney	2.624	0.848	0	.18	
Veal leg	3.296	0.944	0	.22	whole leg
Veal cutlets	3.120	1.632	0	.32	
Mutton – average	2.736	0.928	0	25 to 30	
Lamb – average	2.848	3.616	0	.15, 25, 30	
Pork –fat	2.320	5.968	0	.34	
Pork lean	3.248	1.088	0	.32	
Pork ham	2.960	2.832	0	.34	
Blood – various sources	2.896	0.032	0		None
Blood from fatted beef	3.344	0.160	0		None
Rabbit – whole	3.344	0.160	0	.10	
Hen – flash	3.408	0.728	0	.25	
Salmon	3.157	1.718	0	.30	
Fresh Herring	2.578	1.355	0	.10	
Mackerel	3.090	1.293	0	.18	
Cod	2.675	0.048	0	.12·.5 & .16	
Haddock	2.709	0.042	0	.10	
Dried Codfish	13.046	0.118	0	.10	
Dried & salted codfish	11.579	0.395	0	.10	
Smoked Haddie	4.331	0.058	0	.15	
Smoked & salted herring	5.882	2.518	0	.10	red herring
Sardines	4.544	1.291	0	.32	
Oysters	1.581	0.304	0		None
Caviare	4.694	2.237	0		None
Lobster	3.054	0.156	0	.40	
Beef, dried (pemmican)	11.120	0.934	0		None
Beef, corned	3.469	0.778	0	.18	
Sausages, frankfurters	2.002	6.258	0		None
Sausages Blood	1.739	1.628	3.274	.12.5	containing
Eggs, Hens	2.068	1.938	0	.26	cereals.
Milk, whole milk	0.546	0.606	0.784	.04	
" skimmed	0.422	0.139	0.758	.02	
" condensed, no sugar	1.737	1.827	2.234	.20	
" condensed sugared	1.290	1.533	8.450	.20	American
" condensed sugared	1.673	1.611	8.163	.20	American and
Milk skim–sugared	2.034	0.421	9.037		foreign
" powder, whole milk	3.694	3.702	6.782		
" powder skimmed	4.930	0.279	8.549		
Cream	0.659	3.810	0.627	.25	
Butter	0.122	13.392	0.080	.42	
Oleomargarine	0.158	14.014	0		None
Cheese –cheddar	4.362	5.080	0.538		
" American	4.118	5.482	0.390	.30	
" average quality	4.194	4.729	0.542	.30	
" skim milk	5.694	1.992	0.675		None
" Roquefort	4.235	5.300	0.412		"
Buttermilk	0.626	0.163	0.678	.02	
Infants' Foods, Ridge's	1.392	0.221	13.046	1.00	
Infants' Foods, Mellin's	1.250	0.046	13.213	1.20	
Infants' Foods, Neave's	2.112	0.272	12.494	0.50	
Wheat Flour–Fine	1.709	0.180	11.950	.09	
Wheat Flour–coarse	1.856	0.254	11.742	.08	
Wheat Flour–whole	1.509	0.150	12.147	.07	
Rye Flour	1.529	0.230	11.824	.07	
Oatmeal	2.219	0.989	10.730	.07	
Cornmeal	1.539	0.402	11.472	.07	
Buckwheat flour	1.325	0.238	11.933	.08	
Pea meal	4.115	0.285	9.149		None
Macaroni	1.741	0.099	12.088	.10	
Rice Flour	1.183	0.110	12.652	.10	
Corn starch	0.192	0.002	13.618	.13	
Sago "	0.346	0	13.085	.16	
Tapioca starch	0.118	0.026	11.498	.16	
Potato starch	0.141	0.008	12.909		None
Bread wheat, fine	1.090	0.086	9.248	.07	
Bread wheat, coarse	1.150	0.146	8.158	.06	
Bread Graham	1.296	0.115	8.533	.06	
Wheat biscuits	1.586	0.408	12.464	.20	
Rye bread	1.029	0.182	8.069	.07	
Oatmeal cakes	1.373	1.664	10.669		None
Potatoes	0.318	0.024	3.338	.055	
Artichokes	0.302	0.029	2.624		None
Sweet potatoes	0.251	0.080	3.861		"
Beets –Mangold	0.202	0.021	1.381		"
Beets – sugar	0.198	0.016	2.427	.20	

Each 1 lb. avoirdupois of the food named contains	Proteids ounces	Fats ounces	Carbo-hydrates ounces	Cost of 1 lb Ottawa June 1917	Remarks
Carrots	0.189	0.046	1.450		
Turnips – Swedes	0.222	0.029	1.179		None
Melons	0.134	0.021	1.016	.04	
Cucumbers	0.174	0.018	0.354	.10	
Pumpkins	0.176	0.021	1.024		None
Tomatoes	0.154	0.030	0.638	.20	
Green peas	1.054	0.083	1.989		None
Green beans	0.435	0.022	1.056		?
Asparagus	0.312	0.022	0.384	.02	
Cabbage	0.288	0.032	0.606	.07	
Cauliflower	0.397	0.054	0.728	.50	
Spinach	0.594	0.008	0.578	.07	
Lettuce	0.226	0.050	0.350	.075	
Onions	0.256	0.024	1.661	.08	
Canned peas	0.578	0.134	1.344	.10	
Baked beans	1.144	0.510	2.822	.15 to .20	None
Sugar corn	0.458	0.200	2.973	.12	None
Succotash	0.565	0.139	2.808		
Sauerkraut	0.200	0.086	0.616		None
Mushrooms	0.781	0.032	0.571	.90	
Apples	0.048	0	1.416		"
Pears	0.056	0	1.488		"
Plums	0.162	0	2.477		
Grapes	0.162	0	2.421		
Oranges	0.173	0	0.808	.07	
Dried apples	0.227	0.310	7.726	.13	
Dried apricots	0.494	0	4.138	.18	
Raisins	0.403	0.094	10.843	.15	
Dried figs	0.573	0.203	8.342	.10 to 20.	
Sugar	0	0	15.531	.09	
Corn syrup	0	0	12.866	.19	
Honey	0.227	0	12.032	.15	
Black pepper	1.955	1.243	6.019	.40	
White pepper	1.877	1.053	8.704	.45	
Coffee – roasted	2.261	2.216	9.572	.40	
Tea	3.861	1.318	?	.30 to .60	
Cocoa	3.523	4.536	2.899	.40 to .50	
Peanut butter	4.392	7.608	2.102	.23	
Rolled Oats	1.893	1.058	11.416	.09	
Rolled Wheat	1.403	0.304	12.355	.10	
Shredded Wheat	1.845	0.136	12.242	.20	
"Force"	1.622	0.242	12.301	.24	
Peas dried	4.344	0.350	8.632	.08	

This table might be almost indefinitely extended, and I could wish it to include every available form in which our markets offer food material. Even as here published it will serve to enable us to apply to the cost of food the principles which I have attempted to present in what has been written. The prices quoted are, of course, subject to frequent change; and economical buying involves a constant watching of the local market.

It is desired to ascertain the lowest cost of satisfactory nutrition in case of a family comprising, let us say, three men, of about average weight (150 to 160 lbs) and two women.

Referring to page ~~14~~ 10 it will be seen that this involves the furnishing of :

For the men :	Proteids 12.6;	Fats 6.0 oz;	Carbohydrates 54 oz.	
For the women	" 7.0	" 3.2	" 42	
Total	19.6	9.2	96	

Total energy required is 15838 calories. (From proteids x 116; fats x 264; carbohydrates x 116)

From the tables on pp. ~~15–17~~ 11 12 we find that the necessary proteids may be furnished in many different ways. In choosing certain foods as sources of proteids we incidentally introduce fats, or fats and carbohydrates at the same time; and as a balanced ration is demanded, a certain amount of patience, ingenuity and intelligence is involved. The matter is, however, really very simple; and the thought which must be given to the solution of the problem, should make it all the more interesting to the intelligent housewife.

I here present a few of the numerous solutions of this problem.

Food materials	Quantity lbs	Proteids oz.	Fats oz.	Carbohydrates oz.	Cost
Oatmeal	2	4.438	1.978	21.460	14
Graham bread	4	5.184	0.460	34.132	24
Milk-whole	5	2.730	3.030	3.920	20
Sugar	1	0	0	15.531	9
Beef (brisket)	3	9.168	5.988	0	48
Potatoes	2	0.636	0.048	6.676	11
Corn starch	1	0.192	0.002	13.618	13
Total	18	22.348	11.506	95.337	1.39

This ration show the following departures from the calculated amounts.

Proteids 2.748 oz. excess.
Fat 2.306 " "
Carbohydrates 0.663 " deficiency.

The energy value is :

Proteids 22.348 × 116 = 2592.368 calories.
Fats 11.506 × 264 = 3037.584 "
Carbohydrates 95.337 × 116 = 11059.092 "

Total 16689.044 "
Calculated 15838.000 "

Excess 851.044 "

On the whole this is a sufficiently close approximation to theoretical requirements, and since a little waste is almost unavoidable in cooking and serving, it may be regarded as satisfactory.

The cost is $1.39 for 5 people per day.

Here is another attempt at solution:

Food materials	Quantity lbs.	Proteids oz.	Fats oz.	Carbohydrates oz.	Cost.
Ham	1	2.960	2.832	0	34
Eggs	1	2.068	1.938	0	26
Bread (fine)	4	4.360	0.344	36.992	28
Butter	½lb	0.061	6.696	0.040	21
Milk	3	1.638	1.818	2.352	12
Codfish	3	8.025	0.144	0	45
Sugar	1½	0	0	23.297	13½
Corn starch	1	0.192	0.002	13.618	13
	15½	19.304	13.774	96.298	$1.92½

This ration shows the following departures from calculated amounts.

Proteids ....0.296 deficiency.
Fats..........4.574 excess
Carbohydrates 0.298 excess

Energy value.......17046
Calculated.........15838

Excess............ 1208 calories

The cost of this daily ration is considerably more than in the first case, due to introduction of more fats. The total energy value is however, but slightly enhanced.

It may be worth while to illustrate by a third calculation, in which we shall endeavour to secure the necessary amounts of food at the lowest possible cost.

		Proteids	Fat	Carbohydrates	Cost
Beef, shank	3 lbs	9.840	4.320	0	30
Bread, coarse	4 "	4.600	0.584	32.632	24
Milk, whole	4 "	2.184	2.424	3.136	16
Sugar	2 "	0	0	31.062	18
Oatmeal	1½"	3.329	1.483	16.095	10½
Corn starch	1 "	0.192	0.002	13.618	13
	15½"	20.145	8.813	96.543	$1.11½

This ration indicated a slight excess in proteids compensating a slight deficiency in fats.

The energy value is	15994 calories
Theoretical reauirements	15938 "
Excess	56

The total cost is only $1.11½

It is scarcely necessary to say, that want of care in purchasing material might cause a ration, having no greater food value than the above, to cost two, three or four times the above amounts.

It should be noted that, while the food values assumed in the above rations, are sufficient to maintain energy in persons of average weight, and engaged in work which makes no severe demands, they must be regarded as minimum values, and make no allowance, for unusual fatigue, for waste in use of the food, or for that variety of choice in food materials which is absolutely necessary to prevent loss of appetite. It will be especially apparent that the relation of fats to carbohydrates is kept as low as possible, for the sake of reducing cost.

Statistics prove that the German peasantry are, in large part, fed upon a ration of this character; and I have no doubt that if other countries had accumulated similar, carefully obtained statistical information, it would have proved much the same thing in their cases.

The prolonged use of a diet so relatively poor in fat, results in physiological disturbances which utimately break down the system and induce disease. The comprehensive word which describes this condition is "indigestion" or "dyspepsia" and its exrpession in face and form and temper is so apparent in the experience of every one as to need no emphasis here. The proteid content of the above rations is also too low; and I may quote the following from Professor Rubner, an authority in the field of nutrition study. "The diet of the upper classes is the only one which provides the pleasures of the table; it is rich in proteid and fat; it is not voluminous, does not overburden the stomach, tends less to obesity than any other diet, keeps the body even of a lazy man in good condition, and does not overwork the digestive functions. The less well-to-do, reduce, of course, the amount of meat, using in its place bread and potatoes."

I have already referred to the desirability of increasing the relative proportion of fat in our diet, and have recommended the ratio, Proteids: Fats, Carbohydrates: 4.2: 3: 16 as a decided improvement.

I shall illustrate a ration for our supposed family of 5 persons on this basis;

3 men require......	Proteids	12.6:	Fats	9:	Carbohydrates	48 oz.
2 women require....	Proteids	7.0:	Fats	4.	Carbohydrates	30 oz.
Total......		19.6	"	13	"	78 "

This may be furnished by :

		Proteids	Fat	Carbohy-drates	Cost.
Rolled Oats................	1lb	1.893	1.058	11.416oz	9
Milk.......................	3	1.638	1.818	2.352	12
Ham.......................	½	1.480	1.416	0	17
Bread......................	3	3.270	0.258	27.774	21
Eggs.......................	1	2.068	1.938	0	26
Round steak...............	2	6.528	3.200	0	64
Sugar......................	½	0	0	7.766	4½
Corn starch................	½	0.096	0.001	6.809	6½
Lamb......................	1	2.848	3.616	0	25
	12½	19.821	13.305	56.087	$1.85

Energy furnished..........................14637 calories
Energy required...........................14754 calories

Difference............................... 117 deficiency

I do not pretend to recommend in detail, any particular ration. The reader who has carefully studied what has been said, will have no difficulty in calculating very various rations from the data given; and it should furnish an interesting exercise to anyone seeking household economy, to select, such combinations as will satisfy nature's demands, and, at the same time, form palatable dishes.

It is to be remembered that cooking has much to do with the appetizing character of food, and with its digestibility, consequently with its usefulness to the organism.

Many of the food materials given in the table are not practically available in the form in which they are purchased. This is the case with flour, lard, and others. These are rather to be regarded as constituents of food than as food itself. The housewife who makes tea-cakes, from flour, lard, sugar, etc., can easily calculate the food value of her product, as well as its cost, if she weigh in the ingredients, and also weigh the finished article. The food value of a complex cake if properly baked, is exactly the sum of the food values of the ingredients.

Several matters of importance in this connection, can only be mentioned here. To deal fully with them, would too greatly extend this essay; and would distract attention from the single purpose for which this has been written; namely the importance of giving attention to the nutrient value of our food; and the outlining of a simple method of calculating this value, and of correlating it to the actual cost of available food materials.

Briefly, the matters referred to are the following:

1. Many foods and food materials are on the market in patented or proprietary forms. As a rule, these particular foods are very desirable; frequently they are the choicest forms in which the special article can be purchased. But they are relatively costly, and, regarded from the simple standpoint of nutrient value, they cannot be recommended to housewives whose main object in buying is to secure maximum food value at lowest cost. And it is mainly for this class that I have written.

2. I have not specially considered a dietary for children or for growing youth. The subject is too large to be dealt with usefully within my limits. As a rule, it may be accepted that a somewhat larger proportion of proteid food is required where the body tissues are increasing; that is, where growth is taking place; or in the case of convalescents, where waste is being made good.

3. The minerals matters of food have not been taken into account, Needless to say that these are of equal importance with nutrition as I have defined it. They are ordinarily present in our foods, and we take them incidentally and of necessity when we use natural food materials. In some cases, as where rice has been polished, or where flour has been ground from wheat after removal of the outer coating of the grain (bran) we are using an impoverished food material, and of course we must suffer, unless we supply the material which is lacking, by some equivalent food stuff. For this reason, true economy demands that we should prefer *whole wheat bread*, to the white bread so commonly in use.

4. An examination of the table herein will show that vegetables and fruit possess an apparently negligible value as nutrients. This is not, however, to be interpreted as rendering them useless in the dietary. We are so constituted as to require a certain proportion of non-nutritive material in our diet; if normal digestion is to proceed. In other words, our food must possess a certain bulk, as well as a definite nutrient value. Vegetables supply this bulk, and at the same time introduce certain small amounts of various acids and other components necessary to the enjoyment of our meals, and consequently to health.

5. Condiments, such as salt, pepper and spices, while possessing no nutrient values worth taking into consideration when we regard the minute amounts consumed, are necessary in order to give flavour to our food, and thus to stimulate appetite and the various secretions of the digestive system, through whose agency metabolism takes place.

6. Vitamines, are always present in natural foods, and food materials.

They greatly influence the efficiency of food, as regards growth, and the prevention and cure of disease, although in amount so small as to have escaped attention until quite recently. Anyone desirous of further information regarding Vitamines, may consult Public Health Report, Washington, Vol. 31 pp. 364 to 370; or a paper in the American Journal of Pharmacy for Sept. 1916, p. 410.

In a recent address to the American section of the Society of Chemical Industry, Professor Graham Lusk of Cornell University recommended that, as far as possible, all foods should be purchased with a knowledge of their calorific and nutritive values, and that packaged foods should be labelled with this information. I fear that such action would injuriously affect the sale of many high priced and extensively advertised forms of food.