UNIVERSITY OF MINNESOTA.

Agricultural Experiment Station.

BULLETIN No. 54.

CHEMICAL DIVISION.

SEPTEMBER, 1897.

HUMAN FOOD INVESTIGATIONS.

THE GLUTEN OF WHEAT. THE DIGESTIBILITY AND COMPOSITION OF BREAD.

THE LOSS OF FOOD VALUE BY PROLONGED FERMENTATION IN BREAD MAKING.

THE DIGESTIBILITY OF POTATOES, AND THE LOSS OF FOOD VALUE WHEN POTATOES, CARROTS, AND CABBAGES ARE BOILED IN DIFFERENT WAYS.

THE RATIONAL FEEDING OF MEN.

ST. ANTHONY PARK, RAMSEY COUNTY, MINNESOTA.

EAGLE PRINTING CO., PRINTERS, DELANO.

University of Minnesota.

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HUMAN FOOD INVESTIGATIONS.

THE GLUTEN OF WHEAT.

HARRY SNYDER.

Nature of the Work.—As is well known, there is a great difference in both the food value and the bread making qualities of flour made from different grades of wheat. With the object of determining, as far as possible, the cause of this difference in food value and bread making qualities, samples were obtained of wheat grown in Russia, India, Chili, and Argentine Republic, as well as of spring and winter wheat grown in different parts of the United States.

It was found that the main difference, in the various samples, was in the gluten. There was a difference, not only in the amount of gluten present, but also in the character of the gluten. Two samples of flour containing the same amounts of gluten frequently have entirely different bread making qualities, due to the peculiar composition of the gluten. The gluten of wheat is usually understood to be that part which remains after removing the starch by washing the flour or meal, after it has been made into a dough, with cold water. In the work reported in this bulletin the gluten was obtained by chemical methods.

Composition of Wheat Gluten.—The gluten of wheat is composed of two parts. One of the substances resembles gelatine, and is called gliadin. It is the gliadin which binds together the flour particles to form a dough. Gliadin has been called plant gelatine. The gliadin, by binding together the particles of flour, enables the dough to retain the gas and to become light when the bread is raised. A certain amount of gliadin, or binding material, in a flour is essential;

an excessive amount may cause a flour to form a soft sticky dough and produce a poor quality of bread.

In addition to the gliadin, or binding material, gluten also contains a substance called glutenin, which can be obtained in the form of a fine white powder. The glutenin "serves as a nucleus to which the gliadin adheres," and it prevents the dough from becoming soft and sticky; that is, the glutenin is the material to which the gliadin attaches itself. It is to be observed that the two bodies which compose the gluten of wheat when present in the right proportions aid each other in forming a good gluten for bread making purposes.

As previously stated two samples of wheat may contain the same amount of gluten; the flour from one of the wheats may produce good bread, while the flour from the other wheat may produce bread of very poor quality. In the first wheat sample, the gliadin and glutenin are present in the right proportions to form a good gluten, while in the second wheat the gliadin and glutenin are not present in the right proportions,—there is an excessive amount of either gliadin or glutenin. An excessive amount of gliadin and a small amount of glutenin make a soft, sticky dough. An excessive amount of glutenin and a small amount of gliadin prevent the gas from being retained, and the bread from becoming light.

The gluten of wheat constitutes from 80 to 85 per cent of the total wheat proteids, which are the important muscle forming and vital nutrients. For food purposes, wheat should contain a high per cent of protein. For bread making purposes the gluten should be well balanced, that is, contain the right proportion of gliadin (binding material) to glutenin. The most valuable wheats for both food and bread making purposes are those rich in protein, of which 80 to 85 per cent is gluten, and the gluten is composed of about 60 per cent gliadin and about 40 per cent glutenin. A wheat may produce a good quality of bread and at the same time the bread may possess a relatively low value as food on account of not containing a sufficient amount of protein. On the other hand a wheat may possess poor bread making qualities and still contain a high per cent of protein. That is, good bread making qualities in a wheat are not always indicative of high food value.

The Gluten from Different Types of Wheat.—In the table, the names of the samples and the sources from which they were obtained are first given. The protein includes the gluten and about 20 per cent of other proteid bodies which do not form a part of the gluten. Gluten represents the sum of the gliadin and glutenin as obtained by chemical analysis. The gliadin was obtained by extracting the fine wheat meal with 70 per cent alcohol. The glutenin was obtained by extracting the meal with potash lye after first removing all other proteids.

Samples Nos. 1, 2 and 6 were grown on the University farm. The other samples were obtained through the State Railroad and Warehouse Commission from the places indicated. All of the samples were selected as being the best types which could be obtained.

Comparisons from a limited number of analyses are not so satisfactory as comparisons from a large number, but the qualities of the various wheat samples bear out so well the properties of the gliadin and glutenin bodies that it is very evident that the qualities of the flour are materially influenced by the amount of gliadin and glutenin present in the gluten. This work has been duplicated with flour from different grades of wheat.

In samples Nos. 1 and 2, which may be taken as good types of northern grown hard spring wheat, the gluten contains about 60 per cent gliadin (binding material) and 40 per cent glutenin (material for the gliadin to adhere to). In the so called soft wheat as Nos. 6, 9, and 13, there is from 7 to 13 per cent more of gliadin and a correspondingly less amount of glutenin. It is to be observed that in samples Nos. 1, 2 and 6 the highest amounts of protein are found. The Indian and Chili wheats contain a very low per cent of protein, and the gluten is of an entirely different character from that of hard northern grown wheat.

In samples Nos. 1 and 4 the gluten is quite similar in composition; there is about the same ratio of gliadin to glutenin in both, yet in sample No. 1 there is nearly twice as much gluten and other proteids as in sample No. 4. Sample No. 11, from Argentine Republic, is deficient in gliadin. In frosted wheat there is more gliadin than in similar sound wheat. In frosted wheat a small amount of glucose is formed, and sour acid bodies are readily produced in the flour.

Testing the Quality of Wheat Gluten.—Samples of wheat or flour in which there is an excessive amount of gliadin, or the gluten is otherwise poor, are readily detected in the following way: To an ounce of flour add a sufficient amount of water to form a stiff dough, after allowing an hour for the physical qualities of the gluten to develop place the dough in a small linen or fine cotton bag, work the mass gently with the fingers, while a small stream of water is allowed to flow on the bag. This is continued until the water that drains from the bag is clear, which indicates that the starch has been washed out. The qualities of the gluten can then be observed.

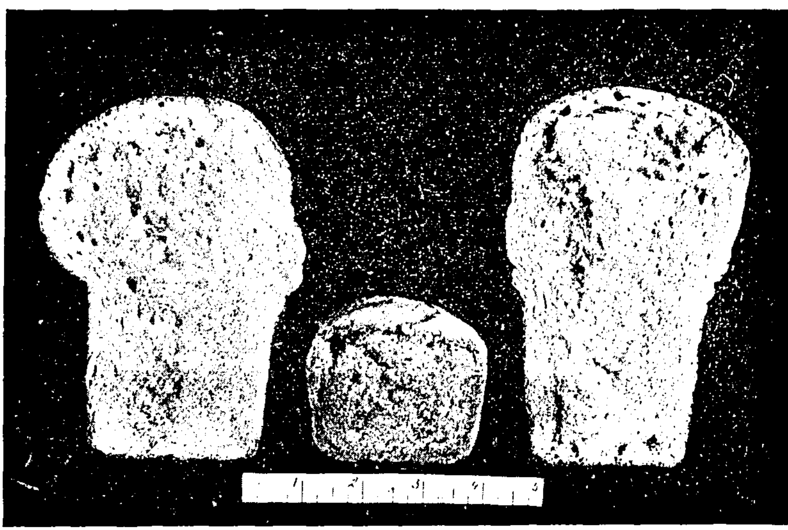
Good gluten is elastic, and when pulled, the threads are long and rope-like. Good gluten is not sticky, when flattened it has a good power to recoil, and it can be kneaded into a thin transparent mass.

Poor gluten is dark in color, very sticky, when pulled, the threads readily break, and are flat and tape-like. Poor gluten has but little power to recoil.

Bread made of Flour from which the Gliadin has been Extracted.—When the gliadin is partially removed from a sample of flour, it has a marked effect upon the bread-making qualities; when the gliadin is entirely removed the yeast has no power to expand the mass and form a light dough. In the illustration, figure No. 2 represents a section of a loaf of bread made of flour from which the gliadin had been extracted, while figure No. 1 represents a section of a loaf of bread made from the same amount of flour from which the gliadin had not been extracted.

When the gliadin was extracted, the dough was not sticky; it felt like putty, and broke off like putty. The yeast caused the mass to expand a little when first placed in the oven, then the top of the loaf began to break apart, and the loaf decreased in size as if no yeast had been used. The loaf, when baked, was about as heavy as the same bulk of rubber.

When any of the wheat proteids, except gliadin or glutenin, are extracted the expanding and bread-making qualities of the flour are not affected. When the albumin is removed (and other water soluble proteids as well), the effect upon the appearance of the bread is not noticeable. Figure No. 3 is a section of a loaf of bread made from flour after extracting the albumin. When the salt soluble proteids (globulins) were extracted, the bread produced was normal in appearance. The gliadin and glutenin are the only proteids which give character to bread—that is, provided the bread is properly made.



No. 1.
Bread made from normal flour. The same amount of flour was used in all of the tests.

No. 2.
Bread made of flour from which the gliadin had been extracted.

No. 3.
Bread made of flour from which the albumin and water soluble proteids had been extracted.

TABLE NO. XXIII.—Composition of the Gluten of Wheat.

	Source.	Protein N. X. 5.7	Proteids in Gluten.	Gliadin.	Glutenin.	Per cent. of Gluten in Form of	
						Gliadin.	Glutenin.
1. Scotch Fife	Minn Ex Station.	14.76	12.46	7.26	5.20	58 3	41.7
2. Wellman's Fife	do	12.60	10.18	6.14	4.04	60.3	39.7
3. Red Winter Wheat		10.73	8.68	5.60	3.08	64.5	35.5
4. Early Genesee Winter		7.98	6.31	3.71	2.60	58.8	41.2
5. Ladoga	Manitoba.	9.54	8.25	5.64	2.61	68.5	31.5
6. Blue Stem	Minn. Ex. Station.	14.20	11.75	7.84	3.91	66.7	33.3
7. Crimean	Russia.	11.08	9.49	5.77	3.72	60.8	39.2
8. Frosted Spring Wheat		12.88	6.39	4.25	2.14	66.5	33 5
9. Calcutta	India.	8.13	6.70	4.90	1.80	73.1	26.9
10. No. 1 Chili	Chili.	7.01	5 62	2.92	2.70	52.0	48.0
11. La Plata	Argentine Rep.	13.38	11.84	4.99	6.85	42.1	57.9
12. Nicolaeff Azima	Russian.	10.28	8.74	5.70	3.04	65.2	34.8
13. Oregon White Winter	Chicago Market.	9.23	7.65	5.42	2.23	70.8	29.2
14. No. 2 Red Winter Wheat	do	7.01	5.56	3.77	1.79	67.8	32.2
15. No. 2 Hard Winter Wheat	do	8.83	7.31	3.99	3.32	54.6	45.4

THE DIGESTIBILITY OF BREAD.

Three experiments were made to determine the digestibility of bread. In the first experiment the bread was made from the best patent grade of spring wheat flour, while in the second and third experiments, bread made from the bakers' grade of flour, and from whole wheat flour, respectively, were used. The experiments were made with a man weighing 150 pounds. The daily exercise consisted of a four mile walk. In each of the experiments the daily ration consisted of about a pound and a half of bread, a fifth of a pound of butter, and half a pound of eggs (4 eggs). The ration was the same in each experiment, except that a different kind of bread was used. The amount of bread, butter, and eggs per day in each of the experiments was as follows:

TABLE No. XXIV.—Food Consumed Per Day.

	Experiment No. 1. Bread from Patent flour.	Experiment No. 2. Bread from Bakers' flour.	Experiment No. 3. Bread from whole wheat flour.
Bread, pounds	1.45	1.48	1.48
Butter, "	.19	.19	.20
Eggs, "	.51	.50	.54

These rations supplied all of the needs of the body and produced sufficient energy for a four mile walk per day. In each of the experiments about 95 per cent of the total nitrogen of the food could be accounted for, indicating that none of the vital functions had been carried on at the expenses of food which had been stored up in the body. This ration may be considered as merely a maintenance ration, and would not be suited for severe labor.

NOTE.—These experiments, as well as the experiments relating to the digestibility of potatoes, the loss of food value by prolonged fermentation in bread making, and the loss of food value when potatoes, carrots and cabbage are boiled in different ways, were made in co-operation with the office of Experiment Stations of the U. S. Department of Agriculture. The details of the experiments are not given but will be published either in the annual report of this station, or in the publications of the office of Experiment Stations.

The rations contained nearly a pound and a quarter of dry matter. The dry matter was composed of about a quarter of a pound of protein, a quarter of a pound of fat, and .85 of a pound of carbohydrates, present principally in the form of wheat starch. The nutrients of the ration were distributed approximately as follows:

TABLE No. XXV.

	Dry Matter. Lbs.	Fat. Lbs.	Protein Lbs.	Carbohydrates. Lbs.
Bread, 1.47 pounds.........	.94	.04	.14	.85
Butter, .20 "	.17	.17	......	......
Eggs, .52 "	.13	.04	.09	......
	1.24	.25	.23	.85

The bread supplied all of the carbohydrates (heat producing nutrients) 65 per cent of the protein (muscle and tissue repairing nutrients), and sixteen per cent of the fat. The four eggs supplied the same amount of fat as the bread, and about 35 per cent of the protein of the ration. If the bread were purchased of the baker at 5 cents per loaf, and the butter cost 20 cents per pound, and the eggs 12 cent per dozen, the ration would cost 15½ cents per day. If the bread were home-made, and the eggs were 9 cents per dozen, and the butter 16 cents per pound, the ration would cost about 10 cents per day, exclusive of the cost of the labor of preparing the materials.

The whole wheat flour which was used in this experiment was a poor type of a whole wheat flour. It was purchased as a high grade flour, but had evidently been made from winter wheat which was deficient in protein. It contained less protein than the bakers' grade of flour, and only a very little more than the white patent flour. The samples of flour from which the breads were made had the following composition:

TABLE No. XXVI.—Composition of Flour Samples.

	Dry Matter Per Cent.	Ash. Per Cent.	Fat. Per Cent.	Protein. Per Cent.	Carbo hydrates. Per Cent.
Patent Flour.....	87.64	.51	1.62	12.44	73.07
Bakers' Flour..............	91.99	.75	2.22	15.50	73.52
Whole Wheat Flour.....	93.50	.98	2.01	12.81	77.60

Omitting the details of the separate experiments, it was found that there was practically no difference in the total digestibility of the bread made from the three kinds of flour. The digestibility of the bread, as found in each of the experiments was as follows:

TABLE No. XXVII.—Digestibility of Bread.

	Bread from Patent Flour. Per Cent. Digested.	Bread from Bakers' Flour. Per Cent. Digested.	Bread from Whole wheat Flour. Per Cent. Digested.
Dry Matter....................................	94	93	93
Protein...	86	84	87
Fat..........................	87	87	86
Carbohydrates.................	97	97	97

In an average sample of bread, the approximate amounts of the various nutrients are represented graphically in figure No. 4. The indigestible starch, fat, and protein are represented by the dark squares in figure No. 5.

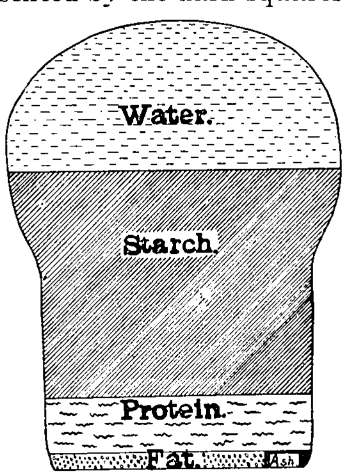


Fig. No. 4.
The Composition of Bread.

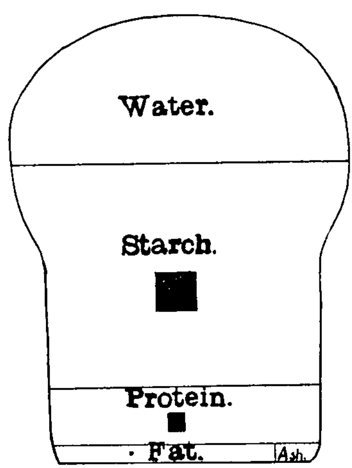


Fig. No. 5.
■ The Indigestible Nutrients of Bread.

COMPOSITION OF BREAD.

There is a greater difference in the composition of samples of bread, than there is in the digestibility of the bread, that is, provided the bread is properly made. Bread as ordinarily used contains about 33 per cent. of water, from 9.5 to 10 per cent. of protein, 2 to 2½ per cent. of fat, about .6 per cent. ash and salt and 54 per cent. of starch.

In comparing the food value of the different samples of bread the preference should be given to the bread containing the most protein. In some cases, however, this would be misleading, as in the bread made from the "Red Dog" grade of flour, which is rich in protein but the gluten is of poor quality and consequently the bread is of poor mechanical condition.

The whole wheat breads are not constant in composition. It is to be observed that the amount of protein ranges from 8.06 to 11.69 per cent. In many cases the whole wheat flours are made from winter wheats poor in protein, which produce a flour poorer in protein than ordinary flour. It frequently happens that whole wheat bread is purchased because it is supposed to contain more nutrients, when in reality it may contain less nutrients than ordinary bread. When the whole wheat flour is made from the best grades of wheat it will contain a little more protein than ordinary flour. It is questionable, in many cases, if this small additional amount of protein is worth the additional price usually charged for such flours. As to the superior merit of whole wheat flour over ordinary flour, it is more a question as to the quality of the wheat from which each flour has been made.

In some of the samples of baker's bread an excessive amount of lard or butter is used, which is indicated by a high per cent. of fat when the bread is analyzed.

The cost of bread is another important item. Three pounds of flour will make a little more than four pounds of bread, on account of the water which has been used in making the bread. At two cent a pound for the flour, four loaves of bread can be made from six cents' worth of flour. With a liberal allowance of two cents for yeast and shortening, the cost of the materials in the four loaves of bread would be about eight cents or two cents a loaf, exclusive of fuel and labor. A barrel of flour costing $4.00, if purchased in the form of bread at five cents a loaf, will cost over $11.00. When flour is more than two cents per pound the cost of bread can be calculated from the figures given:

Flat Bread.—Flat bread is a type of unfermented bread which is quite extensively used in many parts of the state. It is made from either whole wheat or ordinary flour, and is baked in the form of large flat round cakes. Sometimes it is rolled very thin before baking. There is less water in flat bread than in the flour from which the bread was made. The bread is rich in protein and possesses good keeping qualities. The composition of three samples of flat bread was found to be as follows:

TABLE NO. XXVIII.—Composition of Flat Bread.

	Water Per cent.	Protein Per cent.	Fat Per cent.	Carbohydrates.	Ash Per cent.
From whole wheat flour	9.38	15.50	.70	72.92	1.50
From whole wheat "	9.03	15.63	.60	72.64	1.50
From Patent flour.......	10.54	13.44	.20	75.28	.54

The composition of other kinds of bread will be found in the tables at the close of the bulletin.

THE LOSS OF FOOD VALUE BY PROLONGED FERMENTATION IN BREAD MAKING.

In bread making the fermentation process causes a loss of dry matter. This loss by fermentation is not necessarily confined to the sugar, starch and other non-nitrogenous compounds, but the nitrogenous compounds, as the gluten, may also undergo fermentation changes. In wheat and flour nearly all of the element nitrogen is in the form of protein. It is the protein which gives flour its characteristic value as a food. As previously stated, the protein in flour is present mainly in the form of gluten. Thus it follows that any loss of nitrogen, which is the principal element of protein, means a corresponding loss of protein and of food value; hence it is unnecessary to emphasize the importance of preventing excessive losses of nitrogen by fermentation in bread making.

Inasmuch as bread is made in so many different ways, it was thought best to compare the two extreme methods in common use, viz: short fermentation and prolonged fermentation, to determine the nature and extent of the losses when each process is followed. The methods of procedure were essentially as follows: (1) Short fermentation method, making a dough of the flour, water, and yeast, kneading it thoroughly, allowing it to rise until it doubled its bulk, kneading it again thoroughly, when after rising a second time it was baked. (2) Prolonged fermentation method making a batter out of the flour, yeast, and water, allowing this batter to ferment for 10 or 15 hours, usually over night, then adding more flour, kneading and allowing the dough to rise, when it was given the same treatment as in the first method. In the first method a larger amount of yeast was used and the fermentation was carried on for a shorter time and at a higher temperature, while in the second method a smaller quantity of yeast was used, and the fermentation was carried on for a longer time and at a lower temperature.

Seven separate bread making trials are recorded; in four of the trials the bread was made by the slow fermentation process, and in three of the trials by the rapid fermentation process. In the prolonged fermentation trials the fermentation process was continued from twenty to forty hours, a longer time than is usually the case in bread making. The time of fermentation and other details, are given in the tables at the close of the article. About 400 grams of flour (14 ozs.) were first carefully weighed, and the amount of unused flour, after mixing and kneading the dough, was weighed, and deducted from the weight of flour taken. The flour, yeast, and bread were all weighed and analyzed, and the amount of dry matter and nitrogen lost in each of the trials was determined. The bread was all made from one lot of hard spring wheat patent flour. No milk or fat was used in making the bread, thus avoiding complications from the introduction of foreign materials. The details of the separate trials were carried out by Miss A. M. Pattee.

It is not intented to convey the idea that for ordinary bread making purposes so large a quantity of yeast, as was used in some of these experiments, is necessary. An ordinary yeast cake weighs about 12 grams. While the length of time for fermentation as given for some of the trials is excessive, the losses of both dry matter and nitrogen were not in all cases found to be proportional to the time of fermentation. In some of the trials, not reported, it appeared that the greatest losses occurred during the first twelve or fifteen hours of the prolonged fermentation. Briefly stated, the losses were found to be as follows:

Loss of Dry Matter.—When the bread was made by the short fermentation process, there was a loss of 1.74 per cent of dry matter equivalent to a loss of a little more than three pounds of flour per barrel. When the bread was made by the prolonged fermentation process there was a loss of 8.08 per cent of dry matter, equivalent to a loss of about fourteen and a half pounds of flour for every barrel of flour used.

Loss of Nitrogen.—When the bread was made by the short fermentation process there was an average loss of 2.10 per cent of the total nitrogen; with the prolonged fermentation process the loss of nitrogen was 7.77 per cent. When a barrel of flour is made into bread by the prolonged fermentation process, the loss of nitrogen exceeds the loss by the short fermentation process in protein value equal to about seven pounds of the best sirloin steak.

TABLE No. XXIX.—Summary of Losses.

No.	Short Fermentation.		No.	Prolonged Fermentation.	
	Dry Matter. Per Cent Lost.	Total Nitrogen. Per Cent Lost.		Dry Matter. Per Cent Lost.	Total Nitrogen. Per Cent Lost.
1	3.94	1.50	2	11.09	8.14
3	.13	1.76	4	5.94	10.23
5	2.25	1.95	6	9.29	6.80
			7	6 01	5.93
Average	2.10	1.74		8.08	7.77

TABLE No. XXX.—Weight in Grams of Materials used and of Bread Produced.

No.	Flour.	Yeast.	Water.	Time (hours)	Bread.
			Short Fermentation.		
1	353.57	6.85	230	2½	512.76
3	366.34	6.27	230	2½	520.7
5	332.28	6.57	230	2½	445.1
			Prolonged Fermentation.		
2	378.2	1.68	230	23	490.1
4	390.67	2.66	230	22	525.7
6	435.8	2.45	......	40	553.6
7	415.7	2.35	......	23	566.1

TABLE No. XXXI.—Weight in Grams of Dry Matter and Nitrogen in Materials Used and Bread Produced.

Short Fermentation.				
	Flour and Yeast.		Bread.	
No.	Dry Matter.	Nitrogen.	Dry Matter.	Nitrogen.
1	317.7	7.526	312.9	7.229
3	328.6	7.820	322.8	7.81
5	299.4	7.076	293.5	6.917
Prolonged Fermentation.				
2	339.2	7.937	310.6	7.057
4	349.	8.218	313.3	7.73
6	389.2	9.156	362.7	8.304
7	371.2	8.733	355.3	8.208

TABLE No. XXXII.—Composition of Flour and Yeast.

	Flour.	Yeast.
Water, per cent. - - - - - - -	10.853	65.49
Nitrogen, per cent - - - - - - -	2.09	2.00

Composition of Bread Samples.

	1	2	3	4	5	6	7
Water, per cent.	38.962	36.69	38.15	40.44	35.54	34.52	37.23
Nitrogen, per cent.	1.41	1.44	1.52	1.47	1.52	1.47	1.45

THE DIGESTIBILITY OF POTATOES.

The digestibility of potatoes when used as food for domestic animals has been determined by a number of investigators, but few experiments, however, appear to have been made with potatoes as a human food. Inasmuch as potatoes form such an important part of the food of many people, and there is such a difference of opinion regarding their digestibility, it was considered best to determine the digestibility by actual experiment. The experiment was performed with a man weighing about 140 pounds. The daily ration consisted of 3½ pounds of boiled potatoes, 8 eggs, 1½ pints of milk, and half of a pint of cream. It was the intention to confine the ration to eggs and potatoes, but this was found impracticable on account of the potatoes making the ration too bulky. The experiment was carried on for four days. The daily ration contained, approximately, the following amounts of nutrients:

TABLE No. XXXIII.

	Dry Matter lbs.	Ash. lbs.	Protein. lbs.	Fat. lbs.	Carbo-hydrates. lbs.
Potatoes, 3½ pounds	.80	.032	.09	.001	.66
Eggs, 8	.25	.009	.11	.108	——
Milk, 1½ pints	.20	.011	.06	.06	.067
Cream, ½ pint	.09	.003	.01	.075	.008
Total	1.34	.055	.27	.244	.735

The daily ration contained 1.34 lbs. of dry matter. The dry matter was composed of about a quarter of a pound of fat, a little more than a quarter of a pound of protein, and nearly three-quarters of a pound of carbohydrates. This ration supplied all the requirements of the body and produced enough energy for moderately hard labor.

Without entering into the details of the experiment, the digestibility of potatoes was found to be as follows:

	Per cent. Digestible.
Dry matter	89.9
Ash	62.
Protein	67.
Starch and other carbohydrates	94.

About ninety per cent. of the dry matter of the potato was found to be digestible. Of the protein, 67 per cent. was digested. The starch and other carbohydrates were found to be the most digestible of all the nutrients. No figures are

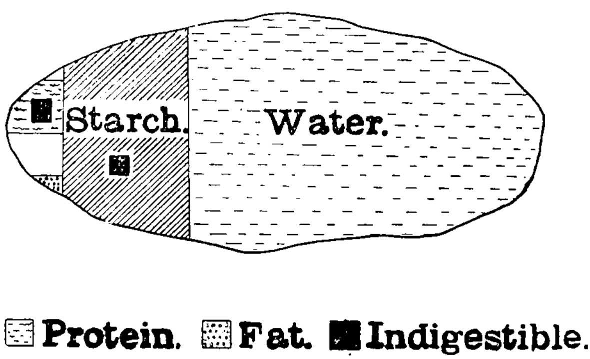


Fig. No. 6. Showing the Composition of the Potato.

TABLE No. XXXIV.

	In 100 pounds of Potatoes.	
	Total Pounds.	Pounds Digestible.
Dry Matter	25.	22.5
Ash	1.0	.6
Fat	.1	——
Crude Protein	2.5	1.7
Fiber	.3	——
Carbohydrates	20.	19.

given for the digestibility of the fat, because the potato contains such a small amount of fat that its digestibility can not be accurately determined. The digestible part of the potato is composed mainly of starch, which is a valuable heat-producing nutrient. The protein of the potato is not as digestible as the protein from other foods. As far as total digestibility is concerned, this experiment indicates that potatoes occupy a high place among our vegetable foods.

The average composition of potatoes, and the amount of digestible nutrients present are as given in Table 34 on preceding page.

THE LOSS OF FOOD VALUE WHEN POTATOES ARE BOILED IN DIFFERENT WAYS.

In boiling potatoes, five or six different methods of procedure may be followed; one of the most common ways is to (1) peel the potatoes, soak them in cold water for an indefinite period, and boil them, starting with cold water. (2) Another way is to omit the soaking, and to place the potatoes directly into either hot or cold water to boil. (3) Sometimes the potatoes are not peeled, but after cleaning, are placed directly into the kettle of either hot or cold water for boiling. The cooking of potatoes so as to retain the highest amount of food value is a very important question.

Lawes and Gilbert have shown that from 80 to 85 per cent. of the nitrogen of potatoes is in the juice, and that the same proportion of the mineral matter may also be in the juice. They suggest that the boiling should be conducted so as to retain the albumin, which is soluble in water. No figures of losses from actual trials are given, but they suggest that the losses may be very large. In Bulletin No. 42, from this station, the losses of albumin were found to range from 2 to 80 per cent. of the total amount in the potato, according to the way in which the potato was boiled.

It was considered advisable to make further trials, using different kinds of water, as hard lime water, alkali water, and distilled water. Twenty-eight separate trials were made. In each trial from three to five fair-sized potatoes were used, the boiling was done in a metallic kettle over a gas flame, at about the same rate as with a good fire in a stove. Both the potatoes and water in which the potatoes were boiled were analyzed.

When the potatoes were peeled, soaked in water five hours, and started in cold water over 57 per cent. of the total nitrogen was extracted and lost. In the earlier trials, reported in Bulletin No. 42, when the potatoes were cut into medium-sized pieces, soaked and boiled slowly, 80 per cent. of the total nitrogen was extracted and lost in the drain water. The losses of nutrients are the heaviest when the potatoes are peeled, sliced, soaked and then boiled slowly, starting with cold water.

The losses of nutrients are the least when the potatoes are not peeled, and are placed directly into hot water, or even cold water, provided the water is warmed rapidly. The loss of total nitrogen is then reduced to about one per cent. When the potatoes are peeled and placed directly into hot water about eight and a half per cent. of the total nitrogen is extracted and lost. If the potatoes are peeled and placed in a kettle containing cold water the losses are much greater. The smaller the pieces and the slower the rate of cooking the greater the losses.

The losses were about the same with hard lime water, alkali water, and distilled water. The losses of starch and dextrin are insignificant compared with the losses of nitrogen and ash. When the potatoes are not peeled the combined losses of starch and dextrin are less than a tenth of one per cent. When the potatoes are peeled the loss of soluble starch and dextrin ranges from .63 to 1.50 per cent.

The loss of such a large proportion of the total nitrogen of the potato is a serious matter. Before cooking there is about one part of protein to every 10 or 11 parts of starch and starch-like bodies. After improper cooking, and losing half of the total nitrogen the ratio is widened to 1 to 20 or more. In a bushel of potatoes a loss of 25 per cent. of the vegetable albumin is equivalent in food value to all of the protein in a pound of sirloin steak. In many cases the losses are even greater than 25 per cent.

These trials suggest, that in order to retain the highest food value: (1) Potatoes should not be peeled and soaked. (2) They should be placed directly into hot water. (3) The potatoes should not be cut into fine pieces. (4) An unnecessarily large amount of water should not be used for boiling.

TABLE NO. XXXV.—Summary Table of Average Per Cent. of Loss.

No. of Trials.		Dry Matter.	Ash	Total Nitrogen.	Starch, etc.
6	Potatoes not peeled and placed in boiling water	.44	3.41	1.05	——
6	Potatoes peeled and placed in kettle of cold water	3.43	16.18	8.52	1.01
6	Potatoes not peeled and placed in kettle of cold water (followed by rapid boiling.)	4.20	2.40	.98	.07
6	Potatoes peeled and placed in kettle of cold water	3.09	18.91	15.92	.99
2	Potatoes peeled, soaked and placed in kettle of cold water	6.48	33.49	51.72	——
2	Potatoes peeled, sliced, soaked and placed in kettle of cold water	——	——	80.	——

THE LOSS OF FOOD VALUE WHEN CARROTS ARE COOKED IN DIFFERENT WAYS.

In the preparation of carrots for the table, it is usually the custom to place the sliced carrots into either hot or cold water, and boil them until they are soft and easily punctured with a fork. The water in which the carrots have been boiled is usually drained off and thrown away. This water is colored yellow and has a very sweet taste, plainly indicating that some of the nutrients of the carrots have been extracted and are lost, and that the boiled carrots have a different composition and food value from the uncooked carrots.

In order to determine just how much food value is lost in the drain water from boiled carrots, twelve separate trials were made, in which lime water, alkali water, and soft water (distilled water) were each used. A sample of the carrots used was analyzed. The carrots were prepared by washing and cleaning with a brush, scraping, and before weighing were dried quickly with a towel to remove surplus water. The drain water, as well as the smaller amount of distilled water used for rinsing were also weighed and analyzed. From the weight and analysis of the carrots and the weight and analysis of the drain waters the amounts of nutrients extracted and lost were calculated. The carrots were sliced in wedge-shaped pieces about four or five inches long. In some of the trials the pieces were smaller, while in others they were larger. The carrots were cooked in a metallic kettle by means of a gas burner, under as nearly normal conditions as possible. The rate of boiling was very similar to that on a gasoline stove.

Composition of the Carrots.—The carrots used contained 12.50 per cent. dry matter, which is practically the amount given for the composition of American carrots. A little over half of the dry matter was cane and fruit sugar,—viz., 6.60 per cent., of which 3.66 per cent. was cane sugar and 3.00 per cent. was fruit sugar and glucose. The amount of nitrogen in the carrots was .18 per cent., equivalent to 1.12 per cent. of crude protein. About 44 per cent. of the total nitrogen was present as albuminoid nitrogen.

The Losses in the Drain Waters.—In the boiling of carrots from a fifth to over a half of the total nutrients are extracted and lost in the water used for boiling. The amount of loss depends more upon the size of the pieces and the rate of boiling than it does upon the kind of water employed. With small-sized pieces and slow boiling half of the nitrogen may be extracted and lost. The most serious losses are of the nitrogenuous compounds and the fruit sugar. There appears to be a larger loss of the nitrogenuous compounds than of sugar. Unlike the potato, there appears to be about the same relative loss of nitrogen when the carrots are placed directly into hot water, as when placed in cold water. This is probably due to the presence of the large amount of sugar and other extractive matters which leave the carrots in such a porous condition that the coagulated albumin cannot be retained.

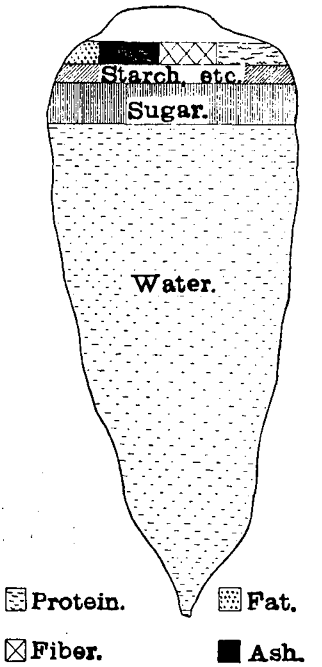


Fig. 7. Composition of a carrot.

These trials suggest that in the cooking of carrots (1) the pieces should be large rather than small, (2) that the boiling should be rapid rather than slow, (3) that as little water as possible should be used, (4) and that this extractive matter should be used as food along with the carrots instead of being thrown away, so as to prevent the loss of the 20 to 30 per cent. of the most valuable nutrients of the carrot.

TABLE No. XXXVI.—Summary. Average Per Cent of Loss.

	Dry Matter	Ash.	Total. Nitrogen.	Sugar.
Carrots cut in Small Pieces............	29.93	47.91	42.49	25.92
Carrots cut in Medium Sized Pieces	23.57	37.45	27.64	26.00
Carrots cut in Large Pieces............	20.18	29.70	20.22	15.40

THE LOSS OF FOOD VALUE WHEN CABBAGE IS COOKED IN DIFFERENT WAYS.

Similar experiments were made to determine the extent of the losses when cabbage was boiled by beginning with hot or cold water. In each trial one half of a fair sized solid cabbage was used. The cabbage was first weighed, and then boiled in a metallic kettle over a gas flame. The drain waters were also weighed and analyzed. The rate of boiling was the same as in the experiments with potatoes and carrots. Distilled water, lime water, and alkali water were each used in the hot and cold water trials.

Composition of the Cabbage.—The cabbage contained 92.52 per cent water, .70 per cent ash, .18 per cent nitrogen, equivalent to 1.12 per cent of crude protein. Sixty-one per cent of the total nitrogen was in the form of albuminoid nitrogen.

The Losses in the drain water from boiled cabbage are very large. Even under the most favorable conditions,—starting with hot water and boiling rapidly—the lowest amount of dry matter lost amounted to 29 per cent of the total dry matter in the cabbage, while about a third each of total nitrogen and ash were lost. The heaviest losses occurred when the cooking was started with cold water, when over 42 per cent of the total dry matter was extrated, and nearly half of the total nitrogen and over half of the ash were lost. On account of the leafy and porous structure of the cabbage a larger amount of surface is exposed to the action of the water used for boiling. In the boiling of cabbage the losses can not be held in check as effectually as in the boiling of potatoes. It is sometimes customary to soak cabbage before boiling, in which case the losses must be even larger. The loss of the dry matter, containing from a third to a half of both the total nitrogen and, ash seriously lessens the food value of the cabbage. It means that when a hundred pounds of cabbages are boiled there is only about 5.50 pounds of dry matter actually consumed, while 2.25 pounds containing the most valuable nutrients of the cabbage are lost.

THE RATIONAL FEEDING OF MEN.

HARRY SNYDER.

Importance.—The object of the rational feeding of man is to supply the human body with the proper amounts of the right kinds of food. In the feeding of man, as in the feeding of animals, the best results are obtained in the way of economy, health, and amount of labor that can be performed, when the body is supplied with the proper nutrients for the production of heat and energy, and for the necessary repair of the worn-out tissues.

In order to discuss the subject it will be necessary to consider the composition of foods, the uses made of foods by the body, the amount of food required for different kinds of labor, the combination of foods to form balanced rations so as to meet all of the requirements of the body, and the comparative cost and value of various kinds of foods.

COMPOSITION OF FOODS.

Many of our common food materials as meat, and the various vegetables are very complex in composition, in fact the exact number and nature of the compounds in an ordinary food material are not known. Although foods are composed of many compounds, the main difference in composition between two foods is, as a rule, confined to a few of these compounds. One food differs from another in containing more or less of some nutrient as starch, sugar, fat or albumin.

In dealing with the composition of foods it is necessary to make use of a number of terms as nutrient, dry matter, organic matter and protein, which will first be briefly defined.

NOTE—This article has been condensed from lecture notes given as a part of the course in chemistry at the Minnesota School of Agriculture. The material has been compiled largely from the works of Konig, Voit, Atwater and the publications of the U. S. Department of Agriculture.

A nutrient is either a compound or a group of compounds capable of serving some purpose as food. Sugar, fat, and albumin are nutrients because they are compounds which can be used by the body as food.

Water as a Constituent of Foods.—All foods contain water. In the white of the egg, in milk, in vegetables and in the juices of meats the water is perceptible, while substances like meal, flour and sugar, which appear perfectly dry, contain water.

Dry Matter, or Solids.—Whenever the water is entirely removed from any substance, the material which is left is called the dry matter or solids. When all of the water is removed from a sample of milk it leaves a brittle shining residue called the milk solids. If a quart of milk is weighed, and all of the water removed in the way to be described, it will be found that about four and a half ounces of solid material are obtained. At the same rate a hundred pounds of milk would give about 13 pounds of solids.

How the Water in Foods is Removed.—The water in any food or other substance is removed by drying the material at the temperature of boiling water. This is accomplished by dry ing in a water oven, which is made of tin or copper and has double walls. The space between the walls is filled with water which is kept boiling.

When any food is dried in such an oven, the water which is present is expelled in the form of steam, leaving what is known as the dry substance or water free material.

These two terms, water and dry matter, are used frequently in speaking of foods. When it is desired to express the amount of water which a substance contains it is always expressed in pounds per hundred of that substance. In all books and tables these figures are given as percentage amounts, which means pounds of water in one hundred pounds of the substance.

In 100 lbs.	of	milk	there are	from	86 to 88	pounds	of	water.
In 100	"	cheese	"	"	30 to 35	"	"	"
In 100	"	flour	"	"	10 to 14	"	"	"
In 100	"	butter	"	"	8 to 15	"	"	"
In 100	"	beef	"	"	50 to 60	"	"	"
In 100	"	chicken	"	"	70 to 75	"	"	"
In 100	"	waterml'n	"	"	95 to 96	"	"	"
In 100	"	sugar	"	"	.1 to 1.	"	"	"
In 100	"	oysters	"	"	86 to 88	"	"	"

The amount of water in other foods is given in the tables of analyses.

It is to be observed that there is a great difference in the amount of water present in food stuffs. Whenever we buy a pound of beef we buy about half a pound of water, and when we buy a barrel of flour, from 20 to 30 pounds of water are purchased. Tomatoes, cucumbers and many other vegetables frequently contain 95 to 96 parts of water in every 100 parts of the vegetable material.

Ash.—The dry matter of foods is composed of a number of separate and quite distinct compounds, some of them as starch, sugar and fat, are familiar bodies. If this dry matter of foods is burned, a small amount of ash is obtained.

In all food stuffs, as eggs, meat and vegetables, there is a certain amount of material that is left after the substance is burned which is called the ash, or mineral, or earthy matter. In all foods there is more or less ash present, just as there is in wood or coal. In the case of milk, there is about three-quarters of a pound of ash in 100 pounds of milk. In all meats there is from a pound to a pound and a half of ash per 100 pounds of the meat. In other food stuffs this mineral matter is present in various amounts as given in the tables of the composition of foods. This mineral matter is a necessary food constituent. The ash of the food is important because it furnishes material for the formation of bones and it also enters into the composition of all of the vital fluids and every part and organ of the body. The ash is composed of a number of constituents as salt, lime, iron, phosphoric acid, etc. Foods differ materially as to the composition of their ash. In potatoes the mineral matter is largely potash, while in grains it is composed largely of phosphates.

Organic Matter.—The dry substance which has been burned is known as the organic or volatile part of the food. The ash is called the non-volatile or inorganic part. The organic matter is obtained by subtracting the ash from the dry matter.

Fats.—One of the nutrients present in all foods is fat. The amount of fat in foods is variable. In 100 pounds of milk there may be present from 3.5 to 5 pounds of fat; in flour fat is present to the extent of one pound in every 100 pounds of flour. In lean meat from a fifth to a third of the total weight is fat. The amount of fat is least in the vegetable food stuffs, and greatest in the animal food stuffs.

There is a great difference in the quality of fat from different foods. In some cases the fat is firm and hard like tallow, while in other cases it may be in the form of an oil. Fat is not a simple material. There are a great many different kinds of separate fats; and in milk there are no less than seven or more separate fats.

The fats are sometimes spoken of when the ether extract materials are meant. Fats are soluble in ether and constitute, nearly all of the ether extract of grains, and animal food products. In fresh green vegetables the ether extract contains a great many other compounds besides fat. The ordinary figures given for the fat content of green vegetables are much higher than the actual amounts of pure fat present, while the ether extract from animal food products, and from most grain products is nearly pure fat.

The amount of fat which various foods contain is given in the tables of analyses.

Fiber.—The fiber includes the cellulose and lignin bodies which constitute the frame work of vegetable substances. The amount of fiber in human food stuffs is usually small. In ordinary flour there is about one part of fiber in 1000 parts of flour. In some foods, as the potato, the amount of fiber is sometimes exaggerated. In the potato there are three or four parts of fiber per 1000 parts of potato. The fiber is not entirely indigestible.

Carbohydrates.—The starch and sugar compounds together with similar substances constitute the carbohydrate group. As ordinarily used the carbohydrates include compounds as the organic acids, or sour principles of vegetables, the jellies or pectose substances, and many other bodies which are not carbohydrates. The term nitrogen-free-extract is frequently made use of to designate this miscellaneous group. The term nitrogen-free-extract means compounds, like starch or sugar, which contain no nitrogen, (nitrogen-free), are easily soluble bodies, and are capable of being readily extracted from foods. The term nitrogen free extract is, as its name implies, a very indefinite one.

The Non-nitrogenous and the Nitrogenous Compounds—The fat, fiber, starch, sugar, and other allied compounds constitute a group to which the name non-nitrogenous compounds is given. The non-nitrogenous compounds contain no nitrogen. Compounds like albumin, casein and fibrin contain nitrogen, and are called nitrogenous compounds. *Non-nitrogenous compounds contain no nitrogen: nitrogenous compounds contain nitrogen.* The divisions into these two classes is an important one, because each class serves a different food purpose. The nitrogenous compounds are by far the most expensive and the most important nutrients found in foods. The nitrogenous compounds are divided into groups.

Protein.—The proteids are the largest and the most important group of the nitrogenous compounds. Unfortunately, the terms used to designate the nitrogenous compounds have been confused. By many the terms proteids, albuminoids, and nitrogenous compounds are used synonymously, but each term has a distinct meaning. The nitrogenous compounds constitute the general class, while proteids and albuminoids are distinct classes of nitrogenous compounds. For food purposes the nitrogenous compounds are, by common usage, collectively spoken of as the crude protein.

Nutritive Ratio.—The nutritive ratio is the ratio which exists between the protein and the non-nitrogenous compounds. A nutritive ratio of 1 to 5.5 means one part of protein to 5.5 parts of non-nitrogenous compounds. In calculating the nutritive ratio the fats are multiplied by 2¼ because they are so much more concentrated than the carbohydrates. In calculating the nutritive ratio the fat, after multiplying by 2¼, is added to the carbohydrates, then this sum, divided by the protein, gives the nutritive ratio. A narrow ratio means a small proportion of non-nitrogenous compounds to protein. A wide ratio means a large proportion of non-nitrogenous compounds to protein.

Miscellaneous Compounds.—In addition to the compounds which have been given, there are a great many other compounds present in foods. Many fruits and vegetables contain essential oils and other similar products which impart flavor and render foods more digestible. Many foods also contain various organic acids, as tartaric acid, found in grapes, and malic acid found in small fruits. The jellies, or pectose substances are also found in many foods. In the potato pectose substances and organic acids are both present. Some foods contain compounds, as tannic, which impart a a negative food value.

In the following chart a classification of the important compounds found in foods is given. A division is first made into water and dry matter. The dry matter is then divided into two parts; ash, and the organic or volatile part. The organic part is in turn divided into two classes of compounds: non-nitrogenous and nitrogenous. Both of these classes are subdivided as indicated on the chart. While the classification may seem somewhat complicated, it must be remembered that when we are dealing with foods we are considering very complex bodies.

Composition of Foods.

- 1. Water
- 2. Dry Matter.
  - 1. Ash.
    - Potash, soda, lime, iron, magnesia, phosphoric acid, sulphuric acid, etc.
  - 2. Organic Compounds.
    - 1. Non-Nitrogenous Compounds.
      - 1. Carbohydrates.
        - Cellulose.
        - Pentosans.
        - Starch.
        - Sugar.
        - Gums.
      - 2. Pectose substances (jellies).
      - 3. Fats.
        - 1. Olein
        - 2. Stearin.
        - 3. Palmitin, etc.
      - 4. Organic Acids.
        - Tartaric.
        - Oxalic.
        - Malic.
        - Citric, etc.
      - 5. Volatile or essential oils, compounds which impart odors.
      - 6. Mixed Compounds.
    - 2. Nitrogenous Compounds.
      - 1. Proteids.
        - 1. Albumins.
        - 2. Globulins.
        - 3. Peptones, etc.
        - 4. Albuminates.
        - 5. Insoluble proteids.
      - 2. Albuminoids as gelatine.
      - 3. Amides as asparagin.
      - 4. Alkaloids,

USES MADE OF FOODS BY THE BODY.

In order to sustain life the body must be supplied with food for the production of heat and for maintaining the body. In the case of growing children an additional amount is required in excess of that required for the two purposes named. Foods should supply all of these needs of the body.

Heat Producing Foods.—Fat, starch and sugar which belong to the non-nitrogenous compounds are generally called the heat producing compounds. A pound of starch, when it is fully digested by the body, produces the same amount of heat as if the starch were burned in a stove. In fact all of our food which is digested produces heat. In order for the functions of the body to be properly performed, a certain amount of heat is required. There is a great difference in the amount of heat which different foods are capable of producing. Some foods are greater heat producers than others.

Heat Units.—The heat which is present in foods is measured by the amount of work which it is capable of doing. The amount of heat required to raise a pound of water .8 of a degree F. is called a Calorie. A pound of sugar or starch will produce 1860 Calories; that is a pound of starch when burned, if all of the heat were used for warming water, would warm 1860 pounds of water .8 of a degree F. The heat produced by foods is sometimes spoken of as the heat units. A pound of starch or sugar will yield 1860 heat units. A pound of fat will produce 4225 heat units, about 2.25 times more heat than a pound of starch.

Starch, sugar and fat not only produce heat but may also be used for the formation of fat in the body. These compounds alone can not produce muscle or sustain life because they contain no nitrogen. The muscles, blood, skin, etc. all contain nitrogen, hence the sugar, starch and fat, are incomplete foods because they supply no nitrogen. The nitrogen of the body must be supplied in the form of protein as albumin, or casein.

Importance of Protein.—The protein compounds are frequently called the muscle forming compounds, a term first used by Liebig. As previously stated they are the most important compounds present in foods. They are the building materials out of which the greater portion of the muscles of the body are formed. They enter into the composition of the bones, tendons and ligaments, hair, skin, nails, nerve tissues, and all of the vital fluids of the body. Every muscular act of the body is carried on at the expense of some protein material. All of these demands for protein in the human body must be met by a liberal supply in the food. It is the protein which is usually the most deficient in our food materials. The protein compounds are the vital nutrients. From what has been said in regard to the protein compounds entering so largely into the composition of the body, the necessity of combining a sufficient amount of protein in our food is apparent. Protein not only performs these functions but it also produces heat. A pound of protein when digested will produce the same amount of heat as a pound of starch or sugar.

Digested Products.—When protein is digested, the nitrogen is excreted in the form of urea. The carbon of the food appears as carbon dioxide, and the hydrogen as water, both of which are expelled in respired air. In order to form carbon dioxide and water the oxygen of inhaled air is essential. In addition to forming completely digested products as carbon dioxide, water, and urea, cleavage products are also formed. The income and outgo of the carbon of the food is studied by Petten Rofer's apparatus, by means of which all of the respiratory products, as carbon dioxide and water are accurately determined.

THE AMOUNT OF FOOD REQUIRED BY THE BODY.

The amount of food which the body requires is determined by experiments. The food is so regulated that the amount of waste matter is entirely replaced by the food consumed. The amount of food which the body demands can be as accurately determined as the amount of fuel required by an engine for different kinds of work. The amount of food required by different persons varies in the same way as the fuel requirements of different stoves. Unlike the stove, the body, when it is not supplied with food, begins to draw upon itself. Making due allowance for individual differences, the average amount of food per day required by a man at moderate physical labor is as follows:

Protein	.25	pounds.
Fat	.25	"
Carbohydrates	1.00	"
Total dry matter	1.50	pounds.

Heat units or fuel value of food about 3300 calaries.

The food consumed should vary with the occupation, the climate, and the characteristics of the individual. The figures for the dietary standards, calculated from many experiments by different investigators, as given by Atwater, are as follows:

TABLE No. XXXVII.—Dietary Standards.

	Protein lbs.	Fat lbs.	Carbo-hydrates lbs.	Fuel Value.	Nutritive Ration.
Man with little physical exercise..	.20	.20	.66	2.450	5.5
Man with light muscular work....	.22	.22	.77	2.800	5.7
Man with moderate muscular w'rk	.28	.28	.99	3.520	5.8
Man with active muscular work..	.33	.33	1.10	4.060	5.6
Man with hard muscular work....	.39	.55	1.43	5.700	6.9

It is to be observed that any increase in the amount of labor performed should be met with a corresponding increase in the amount of food consumed. The food should be regulated according to the amount of work that is to be performed. There is no question that, ordinarily, too little attention is paid to the proper combination of foods so as to furnish the nutrients according to the demands of the body. It is not intended to convey the idea that every particle of food a person consumes should be weighed, and the nutrients which it contains calculated. A general knowledge of the composition of foods will enable one to know what foods can be combined with other foods to advantage.

Some foods are rich in protein, some are rich in fat, while others are rich in carbohydrates. Take for example a few foods as butter, rice, potatoes, eggs and beef. A combination of butter, rice and potatoes would be deficient in protein and would be an unbalanced ration. A combination of beef, eggs and butter would likewise form an unbalanced ration, one rich in protein and fat, and containing no carbohydrates. If the two classes of foods are blended a good balanced ration is the result.

In the combination of foods there is sometimes a tendency to use too much fat. A certain amount of fat in the food is absolutely necessary. The carbohydrates can not entirely take the place of the fats because the body demands a certain amount of concentrated heat-producing food as fat. Too much fat is not only a waste of food but is also a detriment. Four ounces of fat daily is a fair amount, in some cases four or six ounces can be used by the body to advantage, but ten or twelve ounces per day of fat, which is frequently the amount consumed, is too much.

Example of a Balanced Ration.—The combination of foods to form balanced rations is not a difficult matter. Suppose a ration is to be made from bread, butter, potatoes, sugar, eggs, milk and some meat as round steak. The composition of each food should first be noted. In the tables of composition of foods, the nutrients in 100 pounds of the food are given. By moving the decimal point two places to the left the nutrients in one pound of the food are obtained, as follows.

TABLE NO. XXXVIII.

	Protein lbs.	Fat lbs.	Carbohydrates lbs.	Heat Units Calories.
One pound bread contains........	.095	.02	.55	1300
One pound butter contains.......	——	.85	——	3600
One pound potatoes contains...	.02	——	.20	400
One pound sugar contains........	——	——	.98	1600
One pound eggs (with shells)....	.12	.10	——	650
One pound round steak...........	.18	.12	——	870
One pound of milk..................	.04	.04	.05	325

The object is to combine the foods so that about .25 lbs. of protein, .25 lbs. of fat and about one pound or a little less of carbohydrates are obtained. The ration should, in bulk, contain from 1.3 to 1.5 pounds of dry matter and produce about 3000 heat units. Combining the foods named so as to obtain these amounts it would require about 8 ozs. of potatoes, 8 ozs. of steak, 12 ozs. of bread, 3 ozs. sugar, 2 ozs. of butter, 1 pint of milk and 3 eggs.

TABLE No. XXXIX.—Nutrients for One Day.

Quantity.	Food.	Dry Matter. Lbs.	Protein. Lbs.	Fat. Lbs.	Carbohydrates Lbs.
8 ozs.	Round steak.	.16	.09	.06	——
12 ozs.	Bread...........	.50	.07	.01	.41
8 ozs.	Potatoes.. ...	.12	.01	——	.10
3 ozs.	Sugar..........	.19	——	——	.19
2 ozs.	Butter..........	.11	——	.11	——
4.5 ozs.	(3) Eggs......	.07	.04	.03	——
16 ozs.	Milk.............	.13	.04	.04	.05
	Total.........	1.28	.25	.25	.75

The protein of this ration is supplied by the steak, bread, eggs and milk. The butter and steak furnish the larger part of the fat, while the bread, potatoes and sugar supply the carbohydrates. In order to make the ration more complete fruit or vegetables should be added.

A few examples of rations, calculated for average muscular labor, are given. The figures are for the uncooked materials as ordinarily purchased or sold in the market, average allowance being made for waste and refuse parts of the food. With the exception of the sugar and a few other articles, it is to be noted that nearly all of the foods included in the rations may be produced on the farm. The rations are given merely as outlines and may be varied to suit the tastes of the individual. All of the rations should have fruits and vegetables added to make them more complete. The eye should be trained so that the weight of all foods can be approximately determined. One should become acquainted with the comparative bulk and weight of foods so that the quantities required for rations can be told without weighing every article of food.

Notes on the Rations.—It is to be observed that the main sources of protein are cheese, beans, meat, milk, and bread. Other foods, as potatoes and rice, contain some protein, but they contribute but little to the total protein of a ration. The foods which supply fat in the largest amounts are butter, pork, ham, bacon, mutton, beef, cheese, and milk; beans, rice, potatoes, and bread contain but little fat. Nearly all of the carbohydrates are supplied by potatoes, bread, beans, sugar, rice and oat meal.

The rations are not calculated for the most severe muscular labor, but for average farm work. With light work, the amounts of food should be reduced one-third. For hard labor about twice as much food is required as for light work. The same amount of work could not be accomplished equally well with all of the rations. In ration No. III there are 1000 more heat units than in ration No. VI.

Foods which are slow of digestion should be combined with foods which are easily digested. The ration of a laboring man should not consist entirely of easily digested food, because the food will leave the stomach in so short a time that hunger will result although the ration contained the requisite amounts of nutrients.

TABLE NO. XL.—Examples of Balanced Human Rations.

Food Materials.	Amount in Ounces. (For one day.)	Dry Matter in Pounds.	Nutrients.			Heat Units.
			Protein lbs.	Fat lbs.	Carbohydrates. lbs.	
No. II.						
Beans	4	.22	.06	—	.15	397
Pork	2	.11	.01	.10	—	494
Butter	2	.11	—	.11	—	450
Bread	12	.52	.07	.01	.41	979
Potatoes	8	.17	.01	—	.10	103
Sugar	2	.12	—	—	.12	200
Cheese	4	.17	.07	.09	—	500
Eggs	4	.07	.04	.03	—	202
Milk	8	.07	.02	.02	.03	161
Total	—	1.55	.28	.36	.81	3546
No. III.						
Ham	8	.30	.08	.19	—	970
Eggs (2)	—	.04	.03	.02	—	136
Potatoes	12	.15	.02	—	.14	285
Butter	3	.15	—	.16	—	675
Bread	12	.51	.07	.01	.41	979
Milk	16	.13	.04	.04	.05	323
Sugar	3	.18	—	—	.18	300
Oat Meal	2	.12	.02	.01	.09	232
Total	—	1.52	.26	.43	.87	3900
No. IV.						
Mutton Roast	8	.17	.07	.09	—	550
Sugar	2	.12	—	—	.12	200
Butter	2	.11	—	.11	—	449
Milk	16	.13	.04	.04	.05	323
Peas (green)	4	.06	.02	—	.04	100
Rice	2	.11	.01	—	.10	204
Bread	8	.35	.05	.01	.28	653
Eggs (2)	3	.04	.02	.02	—	136
Oat Meal	2	.12	.02	.01	.09	232
Potatoes	8	.12	.01	—	.10	163
Total	—	1.33	.24	.28	.76	3010

Table XL. Continued.

Food Materials.	Amount in Ounces. (For one day.)	Dry Matter in Pounds.	Nutrients. Protein lbs.	Fat lbs.	Carbohydrates. lbs.	Heat Units.
No. V.						
Bacon	4	.18	.02	.15	-----	695
Beans	4	.22	.06	-----	.15	397
Bread	12	.51	.07	.01	.41	979
Butter	2	.11	——	.11	-----	450
Sugar	2	.12	——	-----	.12	200
Potatoes	8	.12	.01	-----	.10	163
Cheese	4	.17	.06	.09	-----	500
Milk	8	.06	.02	.02	.03	160
Total	—	1.49	.24	.38	.81	3544
No. VI.						
Mackerel	6	.08	.06	.02	-----	135
Sugar	2	.12	—	-----	.12	200
Butter	2	.11	—	.10	----	449
Milk	16	.13	.04	.04	.05	323
Bread	12	.51	.07	.01	.41	979
Eggs (3)	—	.06	.03	.02	-----	204
Potatoes	8	.12	.01	-----	.10	163
Oat Meal	2	.12	.02	.01	.09	232
Cottage cheese	8	.05	.04	.02	-----	150
Total	—	1.30	.27	.23	.77	2835
No. VII.						
Corn meal	8	.44	.04	.02	.35	824
Beans	6	.33	.09	—	.22	595
Cheese	4	.17	.07	.08	—	500
Potatoes	12	.16	.02	—	.15	240
Bread	8	.33	.05	.01	.28	650
Butter	4	.21	—	.21	—	900
Total	—	1.64	.27	.32	1.00	3719

NOTES ON THE COMPOSITION OF FOODS.

Beef.—As a general average about fifty per cent. of beef and other meats is water. When the meat is very lean it contains more water than when fat. In very lean round steak sixty-six per cent. as purchased is water, while mediumly fat round steak contains about sixty per cent. water. As a rule, the parts of the animal which contain the most fat contain the least water. The amount of refuse materials, as trimmings, bones, etc., ranges from three to sixty per cent. according to the part and condition of the meat. The refuse matter in ordinary steaks should not exceed twelve per cent. The water and refuse matter of meat make up about sixty per cent. of the butchers' weight. It frequently exceeds this amount. Of the remaining forty per cent., about fifteen per cent. is protein, and twenty-two to twenty-five per cent. is fat. The amount of ash or mineral matter in meat rarely exceeds one per cent. Beef varies so in composition that average figures, unless applied to average samples, are liable to be misleading.

The composition of beef and of all meats depends upon the condition of the animal. When in a very lean condition there is a large amount of refuse matter, and the meat contains a high per cent. of water. When in prime condition, not only is the quality of the meat better, but the meat contains less water and there is less waste and refuse matter. In the tables of analyses the composition of the various cuts of meat is given. The figures make no distinction as to the physical form of the nutrients. A high nutritive value is assigned to many of the cheaper cuts of meats. Although the nutrients in the cheaper cuts are present in less palatable forms, the total nutrients, as a rule, exceed the amounts in many of the more expensive cuts.

In veal there is less fat than in the corresponding parts of beef. In a side of veal there is about six per cent. of fat, while in an average side of beef, as purchased, there is sixteen per cent. of fat. Veal contains more water than beef. In beef there is not so large a proportional amount of protein as in veal. As a general rule the meat from old animals contains less water, more fat, and less protein than the meat from young animals.

Mutton.—The average amounts of refuse matters in beef and mutton are nearly the same. The refuse matter in a side of mutton, as purchased, amounts to about nineteen per cent., in beef, 18.3. There is more solid matter, as a rule, in mutton than in beef. The various cuts of beef, however, contain a little more protein than the corresponding cuts of mutton. Mutton contains more solid matter, somewhat less protein, and more fat than beef.

Poultry.—In chickens and turkeys the refuse and waste materials amount to about a third of the butcher's weight. The lean meat of all fowls is rich in protein. In chickens and fowls, in general, the fat accumulates in various parts of the body rather than being evenly distributed through the tissues. In the goose, however, the amount of fat usually exceeds a third of the weight of the body. The edible portion of poultry contains more protein than the edible portion of beef. Although the per cent. of refuse material is high, the amount of protein obtained from fowls compares very favorably with the amount obtained from beef.

Pork.—The per cent. of water in pork varies according to the amount of fat present. The higher the per cent. of fat the lower the per cent. of water. In lean salt pork about twenty per cent. is water; in fat salt pork about seven per cent. is water. In ham about fifteen per cent., as purchased, is refuse. In bacon there is about eight per cent. of refuse and waste. The amount of protein in pork ranges from 1.8 in salt pork to about 15 per cent. in ham; the fat ranges from 25 per cent. in shoulder to 87 per cent. in salt pork. The high heat producing value and the low muscle-forming value of side pork, compared with other meats, are indicated in the table. A side of pork, as purchased, contains about 11 per cent. of refuse, 26 per cent. of water, 55 per cent. fat, 7 per cent. protein, and .5 per cent. ash.

Fish.—About half of the butcher's weight of fish is refuse. Fish contains a very high per cent. of water. The edible portion of all fish is about three-fourths water. Notwithstanding the fact that such a large proportion of fish is refuse and water, the per cent. of protein is relatively quite high. In the edible portion of fish there is about the same amount of protein as in the edible portion of lean meat. The amount of fat is small in cod and "white fleshed fish," and in salmon it is about the same as in beef. In salted fish there is less water than in the same kind of fresh fish.

Eggs.—About three-quarters of the entire egg (shell removed) is water. The shell makes up about 10 per cent. of the weight of the egg. About 15 per cent. of the egg is protein and 10 per cent is fat. There is a marked difference between the composition of the white and the yellow parts of the egg. The yolk contains 50 per cent. water while the white contains 87 per cent. water. The yolk contains about 31 per cent. of fat and 15 per cent. of protein. There is about the same amount of water in eggs as in potatoes; the potato is a type of starchy food, while the egg is a type of proteid food.

Cheese.—Cheese is a concentrated form of food rich in both protein and fat. The food value of cheese is generally underestimated. Cheese contains about 35 per cent. of fat and 28 per cent. of protein. A pound of cheese is more than equal in food value to a pound and a half of the best sirloin steak. Cheese is sometimes spoken of as indigestible; cheese may be slow of digestion but it is not indigestible. Experiments have shown that nearly all of the protein of cheese and ninety-five per cent of the fat is digestible. Experiments given by Kœnig show that cheese has a very beneficial effect upon the digestibility of other foods. The digestibility of the protein of maize (corn) meal, for example, was found to be 58 per cent. When cheese was added to the maize meal the digestibility of the protein of the ration was 93 per cent. There is no question but what more cheese could be used to advantage in our rations. Cheese is not a luxury, but is one of the cheapest and best of our food articles.

Milk.—Milk is one of the best types of what may be termed a well-balanced food. A hundred pounds of milk contain about thirteen pounds of solid matter. The solid matter is composed of fat, protein, in the forms of casein and albumin, milk sugar and mineral matter. The most variable nutrient in milk is fat, the other nutrients vary but little in different samples of normal milk. In dietary studies by Professor Jordan at the Maine State College the value of milk is given as follows: "The dietaries in which milk was more abundantly supplied were somewhat less costly than the others and at the same time were fully as acceptable." "These results indicate that milk should not be regarded as a luxury, but as an economical article of diet, which families of moderate income may freely purchase as a probable means of improving the character of the dietary and of cheapening the cost of their supply of animal foods."

Wheat Flour.—The variations in the composition of wheat flour are quite pronounced. As a rule flour contains about twelve per cent water; there is more water in flour than in the wheat from which the flour is made. The protein in flour ranges from 7 to 14 per cent, according to the quality of the wheat, and the method of milling employed. In flour made by the roller process there is about 12.50 per cent protein. For bread making purposes, the quality of the gluten which forms the larger portion of the protein, is very important. The composition of gluten, and its influence upon the character of the bread product, are discussed in a preceding article in this bulletin. The per cent of ash in flour ranges from .3 to .9; in the lower grades of flour the per cent of ash is the highest. The amount of starch and starch-like bodies ranges from 68 to 75 per cent. The difference in composition between spring wheat and winter wheat flour is a difference mainly in the character of the gluten; as a rule, however, there is a little more protein in spring wheat than in winter wheat flour.

Buckwheat flour is quite different in general composition from wheat flour. Buckwheat flour contains more starch and less protein than wheat flour.

Corn meal contains less protein than wheat flour, but more than buckwheat flour. Corn meal is frequently so much cheaper than flour that a given sum of money expended in corn meal will procure more total nutrients than the same amount of money expended in flour. When used for human food, corn meal should be combined with foods rich in protein so as to form a well balanced ration. There is no material difference in composition between yellow and white corn meal. It is a difference simply in coloring matter, which is present in the yellow meal and not present in the white meal.

Oat meal is a food which is richer in protein than either corn meal or flour. In oat meal there is about 1 part of protein to every 5½ parts of non-proteid material, which is about the right proportion for a well balanced ration. Some of the breakfast food preparations on the market contain less in the way of nutrients than the prices which are charged for them warrant. Particularly is this true of the preparations made from the starchy parts of corn. The oat starch grain is quite different in structure from the starch grain of other cereals. It is a compound starch grain, made up of segments, which necessitates a different method of treatment in the way of its preparation as food.

Beans and Peas are vegetable foods which are very rich in protein. In a pound of beans there is one-fourth more protein than in a pound of beef. Peas and beans are the only vegetable foods which approach in composition the protein content of animal bodies. In the examples of rations given, it is to be observed that in some of the rations, quite a large proportion of the protein is obtained from beans. Peas and beans should be more extensively used to take the place of expensive meats. But few experiments appear to have been made to determine the digestibility of beans or peas.

Sugar is frequently looked upon as a food adjunct rather than a food. Sugar is a valuable form of food. Granulated sugar is about 99 per cent pure. The per capita consumption of sugar in the United States amounts to about three ounces per day. There are a great many different kinds of sugar, a discussion of which would not be in the province of this bulletin. Sugar is a type of what might be termed a one-sided food; it is capable of producing heat, but alone can not sustain life. Many foods as carrots, beets and corn, contain appreciable amounts of sugar.

THE COST OF FOOD.

The market price of foods is never regulated according to the amount of nutrients which the foods contain. It should be the aim of the purchaser, and the farmer as well, to both buy and sell human food products according to their actual food values. For example, round beef steak is 10 cents per pound, and eggs are 10 cents per dozen, which is the cheaper and better food? At these prices will it pay the farmer to sell the eggs and buy beef? In order to answer this question it is only necessary to calculate the amount of nutrients in 10 cents' worth of each food. The pound of beef steak or 10 cents' worth of steak contains .18 pounds of protein, .11 pounds of fat and produces 780 heat units. Ten cents' worth of eggs will produce .18 pounds of protein, .18 pounds of fat, and 1080 heat units. The same amount of protein can be procured in either the eggs or beef, at the prices stated, but in the eggs over a half more fat can be obtained, which will produce 300 more heat units than the beef, which makes the eggs the cheaper food. When eggs are the same price per dozen that beef is per pound the eggs are the cheaper food.

When comparing two foods as to cost and food value the preference should be given to the food containing the most protein. Where there is but little difference as to the amount of protein, the preference should be given to the food containing the most nutrients in the form of fat and carbohydrates Table No. XLI gives the amount of nutrients which can be procured for 10 cents when the various animal and vegetable foods are at the prices stated. When the prices are different from those given calculations can be made to correspond with other prices.

When milk is 5 cents a quart and round steak is 12 cents a pound, how do the two foods compare in food value? In two quarts, or 10 cents' worth of milk there are .15 pounds of protein, .17 pounds of fat, .2 pounds of carbohydrates and the food will produce 1350 heat units. In 10 cents' worth of 12-cent round steak there are .15 pounds of protein, .09 pounds of fat, and 645 heat units. There is the same amount of protein in each, but the milk contains so much more of the other nutrients that it is by far the cheaper and better food.

When sirloin steak and mutton chops are the same price per pound, 10 cents will buy a little more protein in the form of beef, but the 10 cents' worth of mutton contains more fat which produces 370 more heat units. When ham and beef are the same price per pound about twice as much protein can be procured in the form of beef, while the 10 cents' worth of ham contains about twice as much fat as the beef. The high food value of cheese is also indicated in the table. When cheese and beef are the same price per pound, cheese is by far the cheaper food. Cheese at 18 cents per pound, is as cheap a food as beef steak at 12 cents per pound. The food value of beans is particularly worthy of notice. At 5 cents per pound more protein can be obtained in the form of beans than in any other food. It sometimes happens that when a given sum of money is expended in purchasing two food articles, more nutrients and a better balanced ration can be obtained than if the money were all expended for one food article.

From the table it will appear that at ordinary prices eggs, milk, cheese, wheat flour, oat meal, corn meal, potatoes and beans are among the cheapest foods as far as actual food value is concerned.

TABLE NO. XLI.—The Cost of Food.—Nutrients Obtained for Ten Cents When Foods Are at Different Prices.

(From 1894 Year Book Dept of Agr.)

Food Materials as Purchased. Animal Foods.	Prices per Pound. Cents.	Total Pounds.	Ten Cents will Buy Nutrients. Protein Pound.	Fat Pound.	Carbo-hyd-rates. Pound.	Fuel value Calories.
Beef:						
Neck	4	2.50	0.36	0.28		1825
do	6	1.67	.24	.19		1220
Shoulder	6	1.67	.27	.18		1270
Rib	10	1.00	.13	.21		1140
Sirloin	12	.83	.14	.16		915
do	15	.67	.11	.13		735
do	18	.55	.09	.10		605
Round	10	1.00	.18	.11		780
do	12	.83	.15	.09		645
do	15	.67	.12	.07		525
Veal:						
Shoulder	8	1.25	.21	.11		845
do	10	1.00	.17	.09		675
Loin (chops)	15	.67	.11	.06		445
do	20	.50	.08	.04		335
Mutton:						
Shoulder	5	2.00	.26	.37		2050
do	7	1.43	.19	.26		1465
do	10	1.00	.13	.19		1025
Loin (chops)	8	1.25	.16	.39		1935
do	12	.83	.11	.26		1285
do	16	.63	.08	.19		975
Pork:						
Smoked ham	12	.83	.06	.31		1430
do	16	.63	.04	.24		1090
Smoked shoulder	8	1.25	.16	.41		2030
Salt pork, fat	10	1.00	.04	.69		2995
Fish:						
Fresh cod, dressed	6	1.67	.18	—		340
do	8	1.22	.13	—		255
Fresh mackerel, dr's'd.	12	.83	.09	.03		300

Table No. XLI.—Continued.

Food Materials as Purchased. Animal Foods.	Prices per Pound. Cents.	Total Pounds.	Ten Cents will Buy Nutrients. Protein Pound.	Fat Pound.	Carbo-hydrates. Pound.	Fuel value. Calories.
Salmon	25	.40	.06	.04		270
Salt mackerel	8	1.25	.18	.19		1135
do	12	.83	.12	.13		755
Salt cod, dry	6	1.67	.28	.01		525
do	8	1.25	.20	.01		395
Eggs:						
10 cents a dozen		1.50	.18	.18		1080
15 cents a dozen		1.00	.13	.12		720
20 cents a dozen		.75	.09	.09		540
Milk:						
Sweet, 4 cents a quart	2	5.00	.18	.20	.24	1625
do 5 cents a quart	2½	4.16	.15	.17	.20	1350
Butter	16	.63		.54		2275
do	20	.56		.43		1897
do	25	.45		.34		1583
Cheese.						
Whole milk	10	1.00	.28	.36	.01	1998
do	12	.83	.23	.30	.01	1665
do	15	.67	.18	.24	.01	1420
Vegetable Foods:						
Wheat flour	2	5.00	.55	.06	3.74	8225
do	2½	4.00	.44	.04	2.99	6580
Corn meal	2	5.00	.46	.18	3.56	8250
Oat meal	3	3.33	.50	.24	2.27	6160
Rice	5	2.00	.15	.01	1.59	3260
Wheat bread	5	2.00	.22	.02	1.11	2530
Milk crackers	6	1.67	.16	.22	1.16	3355
Sugar, granulated	5	2.00			2.00	3720
Potatoes, 25 cts. a bu.		2.40	.42	.03	3.66	7680
Beans	3	3.33	.74	.06	1.98	5345

TABLE NO. XLII.—Composition of Human Foods.

(From Bulletins Nos. 28 and 34, Office of Experiment Stations.)

Kind and Cut of Meat. Animal Foods.	Refuse Per Ct.	Water Per Ct.	Nutrients.				Heat Units Calories.
			Water free substance Per Ct.	Protein Per Ct.	Fat Per Ct.	Ash Per Ct.	
BEEF—Chuck ribs:							
Edible portion		57.3	42.7	17.4	24.4	.9	1355
As purchased	13.8	49.3	36.9	15.0	21.1	.8	1170
Loin:							
Edible portion		60.5	39.5	18.3	20.2	1.0	1190
As purchased	13.0	52.6	34.4	15.9	17.6	.9	1040
Neck:							
Edible portion		63.4	36.6	19.2	16.5	.9	1055
As purchased	27.6	45.9	26.5	13.9	11.9	.7	760
Ribs:							
Edible portion		55.4	44.6	16.9	26.8	.9	1445
As purchased	20.8	43.8	35.4	13.4	21.3	.7	1150
Round:							
Edible portion		65.8	34.2	19.7	13.5	1.0	935
As purchased	7.7	60.7	31.6	18.1	12.6	.9	870
Rump:							
Edible portion		56.7	43.3	16.8	25.6	.9	1395
As purchased	21.4	44.5	34.1	13.2	20.2	.7	1095
Shank, fore:							
Edible portion		67.9	32.1	19.6	11.6	.9	855
As purchased	36.9	42.9	20.2	12.3	7.3	.6	535
Shank, hind:							
Edible portion		67.8	32.2	19.8	11.5	.9	855
As purchased	53.9	31.3	14.8	9.1	5.3	.4	395
Fore quarter:							
Edible portion		61.4	38.6	17.5	20.2	.9	1180
As purchased	19.4	49.5	31.1	14.1	16.3	.7	950
Hind quarter:							
Edible portion		61.0	39.0	18.0	20.1	.9	1185
As purchased	15.8	51.3	32.9	15.2	17.0	.7	1000
Cooked, corn'd & cann'd							
As purchased		53.1	46.9	28.5	14.0	4.4	1120

Table No. XLII.—Continued.

Kind and Cut of Meat. Animal Foods.	Refuse Per Ct	Water Per Ct.	Nutrients. Water free substance Per Ct.	Protein Per Ct.	Fat Per Ct.	Ash Per Ct.	Fuel value Per Lb. Calories.
BEEF—Continued. Dried and smoked:							
As purchased		50.8	49.2	31.8	6.8		845
VEAL—Leg, whole:							
Edible portion		70.4	29.6	20.1	8.4	1.1	730
As purchased	15.6	59 4	25.0	16.9	7.2	.9	620
Rump:							
Edible portion		62.6	37.4	20.1	16.2	1.1	1055
As purchased	30.2	43 7	26.1	14.	11.3	.8	735
Fore quarter:							
Edible portion		71.7	28.3	19.4	8.0	.9	700
As purchased	24.5	54.2	21.3	14.6	6.0	.7	525
Hind quarter:							
Edible portion		70.9	29.1	19.8	8.3	1.0	720
As purchased	20.7	56.2	23.1	15.7	6.6	.8	570
LAMB—Leg, hind.							
Edible portion		63.9	36.1	18.5	16.5	1.1	1040
As purchased	17.4	52.9	29.7	15.2	13.6	.9	855
Loin:							
Edible portion		53.1	46.9	17.6	28.3	1.0	1520
As purchased	14.8	45.3	39.9	15.0	24.1	.8	1295
Neck:							
Edible portion		56.7	43.3	17.5	24.8	1.0	1375
As purchased	17.7	46.7	35.6	14.4	20.4	.8	1130
Shoulder:							
Edible portion		51.8	48.2	17.5	29.7	1.0	1580
As purchased	20.3	41.3	38.4	14.	23.6	.8	1255
MUTTON—Leg, hind:							
Edible portion		62.8	37.2	18.2	18.0	1.0	1100
As purchased	18.0	51.4	30.6	14.9	14.9	.8	905
Loin:							
Edible portion		50.1	49.9	15.9	33.2	.8	1695
As purchased	15.3	42.2	42.5	13.2	28.6	.7	1450

Table No. XLII.—Continued.

Kind and Cut of Meat. Animal Foods.	Refuse Per Ct.	Water Per Ct.	Nutrients. Water free substance Per Ct.	Protein Per Ct.	Fat Per Ct.	Ash Per Ct.	Fuel value Per Lb. Calories.
MUTTON—Continued. Neck:							
Edible portion		58.2	41.8	16.3	24.5	1.0	1335
As purchased	28.4	41.6	30.	11.7	17.6	.7	960
Shoulder:							
Edible portion		61.9	38.1	17.3	19.9	.9	1160
As purchased	21.7	48.5	29.8	13.5	15.6	.7	910
Fore quarter:							
Edible portion		51.7	48.3	15.	32.4	.9	1645
As purchased	21.1	40.6	38.3	11.9	25.7	.7	1305
Hind quarter:							
Edible portion		54.8	45.2	16.2	28.2	.8	1490
As purchased	16.7	45.6	37.7	13.5	23.5	.7	1245
Side, without tallow:							
Edible portion		53.1	46.9	15.4	30.7	.7	1580
As purchased	19.2	42.9	37.9	12.5	24.7	.7	1275
PORK—Flank:							
Edible portion		59.	41.	17.8	22.2	1.	1265
As purchased	71.2	17.	11.8	5.1	6.4	.3	365
Ham, smoked:							
Edible portion		40.7	59.3	15.5	39.1	4.7	1940
As purchased	14.4	34.9	50.7	13.3	33.4	4.	1655
Shoulder, fresh:							
Edible portion		57.5	42.5	15.6	26.1	.8	1390
As purchased	46.6	30.4	23.	8.3	14.3	.4	760
Salt, clear fat:							
As purchased		7.3	92.7	1.8	87.2	3.7	3715
Salt, lean ends:							
Edible portion		19.9	80.1	7.3	67.1	5.7	2965
As purchased	11.2	17.6	71.2	6.5	59.6	5.1	2635
Bacon, smoked:							
Edible portion		18.2	81.8	10.0	67.2	4.6	3020
As purchased	8.	16.8	75.2	9.2	61.8	4.2	2780

Table No. XLII.—Continued.

Kind and cut of Meat. Animal Foods.	Refuse Per Ct.	Water Per Ct.	Nutrients. Water free substance. Per Ct.	Protein Per Ct.	Fat Per Ct.	Ash Per Ct.	Fuel value Per Lb. Calories.
PORK—Continued. Side:							
Edible portion		29.4	70.6	8.5	61.7	.4	2760
As purchased	11.2	26.1	62.7	7.5	54.8	.4	2455
POULTRY—Chicken:							
Edible portion		74.2	25.8	22.8	1.8	1.2	500
As purchased	34.8	48.5	16.7	14.8	1.1	.8	325
Turkey:							
Edible portion		55.5	44.5	20.6	22.9	1.0	1350
As purchased	22.7	42.4	34.9	15.7	18.4	.8	1070
FISH, fresh—Cod, dried:							
Edible portion		82.6	17.4	15.8	.4	1.2	310
As purchased	29.9	58.5	11.6	10.6	.2	.8	205
Mackerel, entrails rem'd:							
Edible portion		73.4	26.6	18.2	7.1	1.3	640
As purchased	40.7	43.7	15.6	11.4	3.5	.7	360
Salmon, Cal., sections:							
Edible portion		63.6	36.4	17.5	17.9	1.0	1080
As purchased	10.3	57.9	31.8	16.1	14.8	.9	925
Salmon Trout, whole:							
Edible portion		69.1	30.9	18.2	11.4	1.3	820
As purchased	56.3	30.	13.7	7.7	5.4	.6	985
Trout, brook, whole:							
Edible portion		77.8	22.2	18.9	2.1	1.2	440
As purchased	48.1	40.4	11.5	9.8	1.1	.6	230
FISH, preserved. Cod, salt:							
Edible portion		53.6	46.4	21.4	.4	24.6	410
As purchased	24.9	40.3	34.8	16.	.4	18.4	315
Mackerel, salt:							
Edible portion		42.2	57.8	22.	22.6	13.2	1360
As purchased	22.9	32.5	44.6	17.	17.4	10.2	1050
Salmon, canned, as purchased		64.5	35.5	20.1	11.6	2.4	890

Table No. XLII.—Continued.

Kind and Cut of Meats. Animal Foods.	Refuse Per Ct.	Water Per Ct.	Nutrients. Water free sub-stance. Per Ct.	Protein Per Ct.	Fat Per Ct.	Ash Per Ct.	Fuel value Per Lb. Calo-ries.
FISH, preserved—Con.							
Sardines, canned, as purchased		56.4	43.6	25.3	12.7	5.6	1010
Shell Fish.							
Clams, round:							
Edible portion		86.2	13.8	6.5	.4	2.7	215
As purchased	67.5	28.	4.5	2.1	.1	.9	65
Oysters, "solids," as purchased		88.3	11.7	6.1	1.4	.9	235
DAIRY PRODUCTS:							
Cheese—Chedder		33.00	67.00	28.00	35.00	4.00	1999
Butter		13.00	87.00	.50	85.00	1.5	3600
*Milk		87.00	13.00	3.5	4.00	.7	323
*Cream				2.5	20.0	.5	
EGGS:							
In shell	13.7	63.1	23.2	12.1	10.2	.9	655
Edible portion		73.8	26.2	14.9	10.5	.8	721

*Milk also contains 4.8 per cent. carbohydrates. The fat content of cream ranges from 10 to 30 per cent.

Table No. XLII.—Continued.

Vegetable Foods.	Refuse Per Ct.	Water Per Ct.	Protein Per Ce.	Fat Per Ct.	Carbo-hy-drates. Per Ct.	Ash Per Ct.	Fuel value Per Lb. Calo-ries.
Wheat flours, meals, etc.							
*Roller process flour......		11.9	12.6	.8	74.3	.4	1650
Spring wheat flour...........		11.6	11.8	1.1	75.0	.5	1660
Winter wheat flour.		12.5	10.4	1.0	75.6	.5	1640
Buckwheat flour.............		14.3	6.1	1.0	77.2	1.4	1590
Corn meal, bolted...........		12.9	8.9	2.2	75.1	.9	1655
Oat meal.........................		7.2	15.6	7.3	68.0	1.9	1860
Rice......		12.4	7.8	.4	79.0	.4	1630
Rice, boiled		52.7	5.0	.1	41.9	.3	875
*White bread.....................		31.0	9.9	1.4	57.1	.6	1306
*Graham bread...............		32.2	9.5	2.5	54:7	1.1	
Crackers...........		8.2	10.7	9.9	68.8	2.4	1895
Sugar, granulated......					98.0		1600
Sugar, maple.....................					82.8		1540
Vegetables—Asparagus:							
As purchased.............		94.0	1.8	.2	3.3	.7	105
Beans, dried.							
As purchased...................		13.2	22.3	1.8	59.1	3.6	1590
Beets:							
Edible portion.................		87.6	1.6	.1	9.6	1.1	210
As purchased....................	20.0	70.0	1.3	.1	7.7	.9	170
Cabbage:							
Edible portion...		90.3	2.1	.4	5.8	1.4	165
As purchased....................	15.0	76.8	1.8	.3	4.9	1.2	140
Carrots:							
Edible portion.................		88.2	1.1	.4	9.2	1.1	210
As purchased....................	20.0	70.5	.9	.3	7.4	.9	170
Parsnips:							
Edible portion............		79.9	1.7	.6	16.1	1.7	355
As purchased....................	20.0	63.9	1.3	.5	12.9	1.4	285
Peas, dried:							
As purchased...		10.8	24.1	1.1	61.5	2.5	1640

*From Minnesota Analyses.

Table No. XLII.—Concluded.

Vegetables.	Refuse Per Ct.	Water Per Ct.	Protein Per Ct.	Fat Per Ct.	Carbo-by-drates. Per Ct.	Ash Per Ct.	Fuel. value Per Lb. Calories.
Peas, green:							
Edible portion		78.1	4.4	.5	16.1	.9	400
As purchased	50.0	39.0	2.2	.3	8.0	.5	200
Potatoes, raw.							
Edible portion		78.9	2.1	.1	18.0	.9	380
As purchased	15.0	67.1	1.8	.1	15.3	.7	325
Potatoes, sweet:							
Edible portion		69.3	1.8	.7	27.1	1.1	565
As purchased	15.0	58.9	1.5	.6	23.1	.9	480
Squash:							
Edible portion		86.5	1.6	.6	10.4	.9	245
As purchased	50.0	43.3	.8	.3	5.2	.4	125
Turnips:							
Edible portion		88.9	1.4	.2	8.7	.8	195
As purchased	30.0	62.2	1.0	.1	6.1	.6	135
Tomatoes:							
Edible portion		96.0	.8	.4	2.5	.3	80
Green corn		81.3	2.8	1.1	14.1	.7	360
Cucumber		96.0	.8	.2	2.5	.5	70
Spinach		92.4	2.1	.5	3.1	1.9	120
Sauerkraut		86.3	1.5	.8	4.4	7.0	145