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INDIAN CORN AS FOOD FOR MAN.

DIGESTION EXPERIMENTS WITH CHESTNUTS.

This bulletin contains analyses of Indian corn products; an account of digestion experiments in which corn formed a large part of the diet, with a discussion of the results obtained; and the results of two digestion experiments with chestnuts.

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INDIAN CORN AS A FOOD FOR MAN.

L. H. Merrill.

Among the benefits which accrued to civilized man through the discovery of the New World, the acquisition of Indian corn must be considered as one of the greatest. Its excellence seems to have quickly impressed itself upon the early settlers, and the history of the American Colonies was from the first closely identified with this grain. Since corn is not only a native of the Americas but has been cultivated by the Indians and natives of Central and South America for 20 centuries or more, it is not strange that it was found to be admirably adapted to the climate and needs of this quarter of the globe. The alacrity with which it was adopted by the settlers was in itself sufficient tribute to its excellence. It seems to have been the only food plant cultivated by the Indians, and so exclusively was it grown that the word corn, which formerly signified any cereal food grain, soon lost its original meaning and came to be applied exclusively to Indian corn, although the wider use of the word is still retained in England. It was a long time before this grain ceased to be the most important of our food cereals; indeed, it is scarcely a century since wheat has assumed the leading place to which its superior bread-making qualities entitle it.

Although Indian corn now occupies the second place in importance among the cereals which in this country serve as food for man, it far exceeds wheat in the size and value of the crop produced. In 1611 the James River settlement had 30 acres of corn under cultivation. In 1621 the Massachusetts Bay colony boasted 20 acres devoted to the same crop. In 1905 there were in the United States 94,000,000 acres in corn, and the crop attained the almost incredible size of 2,707,993,540 bushels, with a value of $1,116,696,738. In the same year 47,854,079 acres were given up to wheat, and the crop was 692,979,489 bushels, worth $518,372,727. The acreage of corn

was double that of wheat, and the value of the crops was in about the same proportion.

It is difficult if not impossible to grasp the full significance of such figures as these. Perhaps the imagination might be assisted by supposing the whole State of Maine one immense corn field. It would require more than 4 such fields to equal the area mentioned. If the product of this vast tract were put in bushel baskets, and these baskets could be arranged in a line upon the equator, allowing 18 inches to a bushel, the line would extend around the earth 30 times, and would furnish 30 bushels of grain to every man, woman and child in the United States.

Of course but a small fraction of this amount is utilized as human food. There are no reliable statistics to show how much is thus consumed, but it is doubtful if it exceeds one bushel in 50 of the total crop. Its use today is much more general in the South than in New England, where for the most part it is eaten only at irregular intervals as brown bread, johnny-cake, or occasionally as hominy. The colonists, following the example of the Indians, ate parched corn, either entire or in the form of a coarse meal. The virtues of this latter preparation, known as "nocake," have been highly extolled, and it seemed to fill the high position now occupied by the predigested cereal breakfast food. Other dishes which found favor with the colonists, composed wholly or in part of corn, were hominy, hasty pudding, johnny-cake, brown bread, pone, samp and succotash, the last consisting of green corn cooked with beans. Although wheat has so largely replaced corn, it may be questioned whether we can not profitably make a fuller use of the cereal which seemed to conduce to both the physical and intellectual vigor of our forefathers.

Relative Composition of the Cereal Grains.

A statement of the comparative value of our foods requires the use of certain terms which may be briefly explained here.

Protein. Under the general name protein we include a number of bodies all of which contain nitrogen and most of which belong to the class known as proteids. These bodies possess a peculiar value in that they are absolutely necessary in our foods and cannot be replaced by any other class of compounds, although they may themselves replace to a large extent the fats

and carbohydrates. The fleshy part of the animal body consists largely of protein which can be formed only by the protein of the food. Hence the protein bodies are frequently spoken of as "flesh formers." As examples of protein may be mentioned the gluten of wheat, the curd of milk, and the white of eggs.

Fats or ether extract. Nearly all our foods contain a variable amount of fats and oils. These are readily soluble in ether which is usually employed in the chemical laboratories to remove these bodies. Since the ether also dissolves other bodies which may be present in small quantities, the term "ether extract" is frequently employed as a more exact term, though the shorter term "fats" is often used as being the more convenient. While these bodies possess great value as foods, they may be dispensed with, since the animal is able to form fats from both protein and carbohydrates. Fats are most abundant in the animal kingdom, although very few vegetable foods are entirely free from them.

Carbohydrates. These bodies are by far the most abundant in the vegetable kingdom, the amounts in our animal foods being too small to call for notice. The term includes the sugars and starches and also the woody matter of plants, or cellulose. The sugars are very readily digested as are the starches when properly cooked. The cellulose in the older plant tissues is not easily digested by man. This hardened cellulose constitutes the "crude fiber" of the chemist. The term nitrogen-free extract is often used to denote all the carbohydrates less the crude fiber.

Heat of combustion. The protein, fats, and carbohydrates, so far as they are digested, are all oxidized or burned in the animal body with the production of heat and body energy. The protein is not fully oxidized in the body, but produces, pound for pound, as much heat and energy as the carbohydrates. The fats are the greatest heat producers, yielding weight for weight, 2¼ times as much energy as the protein or carbohydrates. The heat of combustion of a food material is the heat produced by its oxidation. The energy thus developed is measured by calories, a calorie being the amount of heat required to raise one kilogram of water through one degree C., or about one pounds through four degrees F.

The *ash or mineral matter* of a food is what remains behind after the oxidation is complete. Being already fully oxidized it can furnish no energy, although the ash constituents may be absolutely essential to the animal.

In the table below is given the average composition of the principal cereals used for food. The analyses are quoted from Bul. 13, Part 9, Bureau of Chemistry, U. S. Department of Agriculture. With the exception of the rice, the analyses represent American grown grains.

Average composition of cereal grains.

	Water.	Protein.	Fat.	Crude fiber.	N-free extract.	Ash.	Heat of combustion.*
	Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent.	Cal. per lb.
Barley, unhulled	10.85	11.00	2.25	3.85	69.55	2.50	1735
Indian corn	10.75	10.00	4.25	1.75	71.75	1.50	1799
Oats, unhulled	10.00	12.00	4.50	12.00	58.00	3.50	1791
Rice, hulled	12.00	8.00	2.00	1.00	76.00	1.00	1716
Rye	10.50	12.25	1.50	2.10	71.75	1.90	1743
Wheat	10.60	12.25	1.75	2.40	71.25	1.75	1750

* Calculated.

From an inspection of the table it will be seen that of the six cereals considered, corn ranks fifth in the amount of protein which it contains, carrying only about four-fifths as much protein as wheat. On the other hand, with the single exception of oats, it contains far more fat than the other cereals and two and one-half times the quantity found in wheat. It is comparatively poor in fiber and ash, but leads in the heat of combustion, a fact that is due to the large proportion of fat which it carries.

Since the cereals are purchased for the most part in the form of flours or meals, comparisons based upon the relative composition of these products would be more valuable than those just made. In most of the digestion experiments carried out at this Station, Pillsbury's Best flour and a granulated corn meal have been used. In the following table the composition of these materials is compared with that of the original corn, with hominy, and also with meal prepared by the old process, still used in some sections of the country.

Average composition of corn products used in digestion experiments compared with wheat flour.

	Water.	Protein.	Fat.	Carbohydrates.		Ash.	Heat of combustion.
				Crude fiber.	N-free extract.		
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Cal. per lb.
Corn	10.75	10.00	4.25	1.75	71.75	1.50	1796
Hominy	10.96	9.44	.67	.37	78.24	.32	1808
Corn meal, unbolted	10.30	7.50	4.20	65.90		1.20	1544
Corn meal, bolted	11.60	8.40	4.70	74.00		1.30	1728
Granulated meal	11.79	8.50	.98	.46	77.79	.48	1734
Granulated meal	7.77	8.69	1.92	.40	80.72	.50	1825
Wheat flour	11.09	11.37	1.33	.13	75.44	.64	1771

The corn meal formerly found upon the market consisted merely of unbolted ground corn, the composition of which was practically identical with that of the grain from which it was prepared. Such meal was commonly sifted before it was used, the bran and other coarse particles being thus removed. While such meal may still be found upon the market, being extensively used as food for stock, that used as a food for man is generally bolted before the meal leaves the mill, the offals or bran being sold as cattle food. Since the fat or oil, so abundant in corn, is confined largely to the germ, and since the oil is peculiarly subject to changes resulting in rancidity, the presence of the germ is predjudicial to the keeping qualities of the meal. This has lead to the production of the so-called granulated corn meal, obtained by the use of roller-mills. Instead of reducing the kernel to the desired fineness by a single operation, it is first crushed by a machine known as a degerminator which so loosens the germ and hull that they may be removed before the final grinding. It is evident that the composition of the product thus obtained will differ in several very important respects from that previously described, being poorer in fat, through loss of the germ, and also poor in crude fiber or woody matter, which

is found for the most part in the rejected outer coating or the bran. These differences are well shown in the above table. In the manufacture of hominy the germ is also removed, with marked effect upon the proportion of fat in the product. It will be noted that in the manufacture of both hominy and granulated corn meal two-thirds or more of the ash constituents are removed. While small amounts of these salts play a very important part in the animal economy, there is reason for believing that the most of our foods carry them in such large excess that the removal of a part of them in this case is no cause for uneasiness.

Digestibility of Corn Products.

The statement has been made that corn meal is less digestible than wheat flour; that our forefathers ate corn rather than wheat from necessity, and digested it because they could; whereas the present less stalwart generation digests corn less readily, and finding a better cereal at hand is wise in eschewing the first. As a part of the work of the nutrition division of the Office of Experiment Stations a number of digestion experiments with corn have been carried out at this Station. The reader is referred to a later publication of that office for details of this investigation. Only the general results with a brief outline of the methods employed are given here. The experiments were performed with human subjects, and were continued for periods of 6 days each. During this period each subject received daily weighed amounts of food of known composition. The feces corresponding to the food eaten were collected and analyzed. In similar experiments with cattle it is usually assumed that the difference in composition between the food and the feces proceeding from the same represents that part of the food which is utilized in the body; in other words, that the feces consist only of undigested food. In point of fact, this is not strictly correct, since we know that the feces consist not only of undigested food, but contain also small amounts of waste matters resulting from the natural wear of the body together with certain secretions, known to the physiological chemist as metabolic products, which have found their way into the intestines and have not been entirely reabsorbed, and which thus contribute to the volume of the feces. Sometimes, espec-

ially when the amount of food eaten is small, the error thus introduced is too large to be ignored, particularly in the case of the protein. Several methods have been devised for correcting this error so far as it affects the protein, and such a correction has been applied in the results quoted beyond.

The corn products used in these experiments were hominy and granulated corn meal. The first was cooked in the usual manner and was eaten in one experiment with cream and sugar, in another experiment with a mixed diet, including bread, meat, canned peaches, butter, and sugar. The corn meal was eaten in the following forms: 1. Hasty pudding. 2. Johnny-cake. 3. Brown bread. 4. Hoe-cake. The hasty pudding was prepared by stirring the meal into salted water and cooking in a double boiler. In both johnny-cake and brown bread equal weights of meal and flour were used. The formulas used follow:

Formulas for johnny-cake, brown bread and hoe-cake.

	Johnny-cake.	Brown bread.	Hoe-cake.
	Grams.	Grams.	Grams.
Corn meal	100.0	100.0	100.0
Flour	100.0	100.0	.....
Salt	5.0	4.0	5.0
Sugar	10.0	.....	5.0
Baking powder	4.4	4.4	.....
Molasses	.....	40.0	.....
Water	.....	.....	400.0
Milk	150.0	200.0	.....

The brown bread was steamed in tin cans made for the purpose, somewhat conical in form, and provided with covers. Four loaves were cooked at once, the cans being immersed to half their depth in boiling water in a large pan having a perforated false bottom and a cover with a small opening. The loss by evaporation was very small, and the process, once in operation, required no further attention during the 4 hours allowed for the cooking.

Neither flour or baking powder were used in the preparation of the hoe-cake. The hot meal was stirred with boiling water until a thick pudding was formed, which was then spread in thin sheets upon the hot, well-greased iron plates and baked at once. In all the work care was taken to insure thorough cooking.

Average composition and heat of combustion of the corn meal and white flour breads used in the digestion experiments.

	Water.	Protein—(N×6.25).	Ether extract.	Carbohydrates.		Ash.	Heat of combustion.
				Crude fiber.	N-free extract.		
FRESH.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Cal. per lb.
Johnny-cake	29.4	7.8	2.2	.2	57.5	2.9	1384
Brown bread	43.9	6.3	2.1	.1	45.7	1.9	1119
Hoe-cake	52.8	4.0	.6	.2	40.0	2.4	886
White flour bread	40.7	6.9	.3	.1	49.8	2.2	1135
WATER-FREE.							
Johnny-cake	.....	11.3	3.0	.3	81.3	4.1	1960
Brown bread	.....	11.1	3.7	.2	81.7	3.3	1994
Hoe-cake	.....	8.4	1.2	.4	84.9	5.1	1874
White flour bread	.....	11.7	.4	.1	84.1	3.7	1914

The compositions of the breads eaten is shown in the above table. It will be noted that the breads vary greatly in the proportion of water which they contain, with a less marked variation in the other ingredients. When these analyses are reduced to a water-free basis, as shown in the second part of the table, these differences become very much less. Thus, the dry matter of the johnny-cake has almost exactly the same composition as the dry matter of the brown bread, a fact that is not surprising when it is remembered that nearly the same formulas are used for both.

A wide difference in the protein contents between these breads and the white flour bread might have been looked for, since wheat flour is much richer in protein than corn meal. That so slight a difference exists must be attributed to the use of white

flour and milk in the preparation of the johnny-cake and brown bread, while the white bread was mixed with water. The hoe-cake carries much less protein than the other breads, neither white flour or milk being used in its preparation.

Since the differences in water content and the other differences resulting therefrom actually exist in the foods as eaten, the composition of the fresh materials is, after all, the matter of first importance. As eaten, the hoe-cake possessed only about two-thirds the food value of the johnny-cake and brown bread, while the last mentioned was distinctly inferior to johnny-cake in the amounts of nutrients which it contained. In practice it was found that the quantities of bread required and eaten were inversely proportional to the water content.

Several of the digestion experiments reported on the following pages were made with 2 subjects and most of them with 4. The results given in the table are the average of those thus obtained. With all the corn products a double series of trials was made, one with a " simple " the other with a " mixed " diet. In the case of the hominy and hasty pudding the simple diet consisted of the products named with milk and sugar as accessory foods. With johnny-cake, brown bread and hoe-cake, butter was used in addition to the above. The mixed diet included meat and canned peaches. The men enjoyed excellent health throughout the investigation, and while the diet at times proved monotonous, they retained good appetites throughout the experiment.

The results of these experiments are given in the table on the following page. The digestibility of the protein is shown in the first two columns, in the second of which corrections for metabolic products have been applied, as explained on page 138. While it is not claimed that the method adopted for this purpose gives absolutely correct results, there can be no doubt that the corrected figures furnish a more accurate idea of the food value of these materials, and in the discussion which follows these results only will be considered.

Digestibility of nutrients and energy of total food.

	Protein.		Carbohydrates.	Heat of combustion.
	Not corrected for metabolic products.	Corrected for metabolic products.		
	Per cent.	Per cent.	Per cent.	Per cent.
Hominy, simple diet	83.6	89.2	99.0	96.4
mixed diet	88.9	93.6	98.8	96.3
Hasty pudding, simple diet	82.3	89.2	99.0	95.9
mixed diet	89.0	94.0	98.9	96.9
Johnny-cake, simple diet	89.6	94.9	98.7	93.8
mixed diet	90.1	94.8	99.3	93.9
Brown bread, simple diet	87.4	94.7	98.7	93.5
mixed diet	89.5	95.5	99.4	92.9
Hoe-cake, simple diet	87.0	93.9	98.7	93.7
with syrup	84.4	92.6	99.2	95.5
mixed diet	90.0	94.6	98.8	92.6
White bread, simple diet	89.2	94.0	98.9	94.0
mixed diet	92.6	96.1	99.0	98.2

Discussion of the Results Obtained by the Digestion Experiments.

1. In every case but one, the protein of the mixed diet was more completely digested than that of the simple diet. The low digestibility of a simple diet has been often noted in previous experiments.

2. With a simple diet the protein of the johnny-cake and the brown bread seems to have been slightly more digestible than that of the white bread. With the mixed diet, the white bread shows a digestibility distinctly greater than that of the corn breads.

3. The use of syrup with the hoe-cake to a slight degree depressed the digestibility of the protein. This is in accordance with other experiments in which the digestibility of the protein apparently varied with the ratio existing between the protein and the other nutrients.

In this connection attention may be called to the large proportion of carbohydrates in the food used in this work. The requirements of the body seem to be most economically met by

a selection of foods supplying protein, carbohydrates, and fat in certain proportions, although the two latter classes of nutrients may replace each other to a considerable extent, a pound of fat supplying about as much energy as 2¼ pounds of carbohydrates. The proportions generally accepted as well adapted for an average person of active habits are one of protein to 5 or 6 of carbohydrates or the equivalent in fat. The proportions as found in the food of these experiments are shown in the table below.

Ratio between the protein, carbohydrates, and fat of food, one part of fat being considered as equivalent to 2¼ parts of carbohydrates.*

	Simple diet.	Mixed diet.	Simple diet with syrup.
Hominy	1:13.1	1:6.8	
Hasty pudding	1:11.8	1:7.3	
White bread	1:8.8	1:6.0	
Johnny-cake	1:8.3	1:6.9	
Brown bread	1:8.5	1:6.9	
Hoe-cake	1:9.7	1:6.9	1:15.4

* This is not quite the same as the "nutritive ratio" of stock feeders, which is based upon the digestible nutrients only.

With the simple diet, consisting largely of corn relatively low in protein, the ratio is much wider than the standard mentioned, ranging from 1 : 8 to 1 : 13. With the mixed diet, containing meat, which is rich in protein, the ratio was narrowed to about 1 : 7. On the other hand, by the addition of syrup to the simple hoe-cake diet, a ratio originally too wide became still wider, 1 : 15.4, and the digestibility of the protein suffered.

4. From an inspection of the carbohydrate column it is difficult to draw any conclusion farther than that the carbohydrates are almost completely utilized in the body, whether they are derived from white bread or from any of the corn foods studied. The results shown in the last column are even less conclusive and seem to follow no discoverable law.

The figures already quoted relate to the total food eaten. By many experiments the digestibility of such simple articles of food as milk, butter and sugar has already been determined.

By accepting these factors and applying them to the accessory foods of a simple diet, it is possible to calculate the digestibility of the cereal itself. The figures given in the next table were thus obtained.

Digestibility of nutrients and energy of corn preparations alone.

	Protein.		Carbohydrates.	Heat of combustion.
	Not corrected for metabolic products.	Corrected for metabolic products.		
	Per cent.	Per cent.	Per cent.	Per cent.
Hominy	74.5	84.3	98.2	94.4
Hasty pudding	73.2	83.9	98.3	93.1
Johnny-cake	86.3	93.2	98.9	93.5
Brown bread	83.0	92.8	98.6	93.4
Hoe-cake	77.1	88.9	98.6	93.8
Hoe-cake with syrup	78.8	90.0	98.7	94.0
White flour bread	85.6	89.8	98.9	94.0

A comparison of this table with that given on page 142 indicates that these corn foods are either considerably less digestible than the other foods with which they were eaten, or they themselves become more digestible when eaten with other foods. Similar results obtained with other experiments in which certain foods were eaten both singly and with a mixed diet indicate that the second conclusion is the correct one.

A Balanced Diet.

Attention has been called to the fact that in most of the experiments here reported the diet adopted was one-sided, i. e., the proportion of protein to the fats and carbohydrates was too small. This is so common an error in diet that it may be proper to mention a few of the ways in which it may be corrected. It is evident that Indian corn in itself is too poor in protein to form a large part of the diet unless special pains are taken to maintain the proper balance. This may be done in several ways. By the addition of meats, fish, eggs, or vegetable

foods rich in protein, such as beans or peas, the balance may be restored. The same result may be accomplished by the free use of milk instead of water in the preparation of corn foods. The value of milk in thus furnishing protein is not so fully appreciated as it should be. A quart of whole milk carries more protein than one-third of a pound of beef round. Skim milk is both better and cheaper for this purpose, since it carries a slightly higher percentage of protein than whole milk, and contains very little fat. Two quarts of skim milk, costing but 5 cents, furnish nearly as much protein as a pound of beef round, and more real nutriment than a quart of oysters costing 35 or 40 cents. Yet the skim milk is too frequently wasted or fed to calves and pigs. The intelligent housewife may easily find a hundred ways in which this valuable by product could be more directly and profitably utilized as a food for man.

The use of large amounts of butter, pork, or other fatty foods in connection with corn foods is to be deprecated, since the difficulties in the way of establishing a proper balance between the protein and other nutrients is thus increased. The effect of syrup in depressing the digestibility of protein has already been alluded to. Sugar and molasses are open to the same objection and for the same reason. The craving for these food accessories is an example of the fact that the appetite is not always a safe guide.

The coarsely milled forms in which corn is placed upon the market naturally call for more prolonged cooking, not only to break down the starch grains, but to rupture the walls of the cells and thus expose their contents to the action of the digestive juices. It is probable that much of the difficulty occasionally experienced in digesting corn breads might be avoided by a careful attention to these facts. At present there is but little difference to the consumer in the retail cost of corn meal and wheat flour. Both are among the cheapest of our foods. The question of economy need not be considered in choosing between the corn and wheat breads. In general it may be said that the corn products are more digestible than is commonly supposed. Not only their digestibility, but their cheapness and the readiness with which they may be converted into palatable foods suggest a more extended use and entitles them to a much higher place in the popular estimation.

DIGESTION EXPERIMENTS WITH CHESTNUTS.

L. H. Merrill.

A few years ago this Station made quite a study of the nutritive value of nuts, the results of which were published in Bulletin No. 54.* At that time it was planned, as part of the nutrition investigations in cooperation with the U. S. Department of Agriculture, to make digestion experiments with mixed diets in which nuts should form an important part of the food consumed. Only two such experiments with chestnuts were made. The results have been held unpublished hoping that opportunity would come to add to the number of experiments with chestnuts, and also with other nuts.

As shown in the following table, chestnuts differ materially from most other nuts in carrying large amounts of carbohydrates, but little fat, and for the most part relatively small amounts of protein. In fact, they more nearly resemble Indian corn in composition than ordinary nuts.

The dry matter of the meats (kernels) of chestnuts compared with the meats of other nuts† and with corn meal.

	Protein.	Fat.	Carbohydrates.	Ash.
	Per cent.	Per cent.	Per cent.	Per cent.
Almonds	22.1	57.6	18.2	2.1
Filberts	16.2	67.8	13.5	2.5
Pecans	10.6	72.9	14.7	1.8
Walnuts	17.2	66.3	15.2	1.3
Chestnuts	11.3	11.0	75.2	2.5
Corn	11.2	4.8	82.4	1.7

*Nuts as Food, Bul. 54, Maine Agricultural Experiment Station, 1899.

† Analyses taken from Bulletin 54 of this Station.

THE EXPERIMENTS HERE REPORTED.

In the experiments a mixed diet was used in which chestnut flour made a prominent part. Each subject consumed daily 300 grams of the chestnut flour, which furnished about one-fifth of the proteids, one-half of the fat, nearly one-half of the carbohydrates and three-eighths of the total fuel value of the food.

In the table which follows, there is given the chemical composition of the food materials used. The chestnut flour was prepared by shelling the nuts, which were then partly dried and blanched by 20 to 30 seconds immersion in boiling water, again dried, and ground. The bread was made from a straight flour from Northwestern grown wheat. The whole milk was drunk at the meals and the skim milk was used in making the bread. The chestnut flour was eaten as mush.

The details of the experiment are given in the tables on page 148.

Percentage composition of the chestnuts from which the flour was made and of food materials used in the digestion experiments here reported, and heats of combustion per gram, calculated to water content at time when used.

Laboratory Number.	Experiment Number.	Material.	Water.	Nitrogen.	Protein.	Fat.	Carbohydrates.	Ash.	Heats of combustion. Determined.
			%	%	%	%	%	%	Cal.*
6393..	.....	Whole nuts	40.00	.....	3.40	1.90	42.50	1.20	2.120
6393..	.....	Kernels (meats flesh)	44.89	.....	3.85	2.10	47.75	1.41	2.372
6416..	39-40	Chestnut flour	6.36	1.02	6.38	3.32	81.54	2.40	3.958
6417..	39	Bread	35.39	1.73	10.81	.52	51.28	2.00	2.799
6418..	40	Bread	38.65	1.64	10.23	.49	48.55	2.08	2.639
6374..	39-40	Potato	75.46	.37	2.32	.20	21.02	1.00	1.002
6420..	39-40	Milk	87.63	.57	3.56	3.29	4.84	.68	.732
6419..	39-40	Skim milk	90.37	.62	3.88	.48	4.61	.66	.456
6421..	39	Feces	6.17	6.35	39.69	12.15	27.23	14.78	5.132
6422..	40	Feces	6.19	6.16	38.50	11.28	25.85	18.18	4.775

* Calories per gram.

DIGESTION EXPERIMENT No. 39.

Kinds of food: Chestnut flour, bread, potatoes and milk.
Subject: E. R. M. Age 23 years.
Weight (without clothes); at beginning 136.7 lbs., at close 134.1 lbs.
Duration: 3 days, 9 meals.

Laboratory Number.		Weight of material—Grams.	Total organic matter—Grams.	Protein N x 6.25—Grams.	Fat—Grams.	Carbohydrates—Grams.	Ash—Grams.	Heat of combustion—Calories.
6416	Chestnut flour	900.0	821.2	57.4	29.9	733.9	21.6	3562
6417	Bread	1275.0	798.3	137.9	6.6	653.8	25.5	3569
6374	Potatoes	40.0	9.4	.9	.1	8.4	.4	40
6420	Milk	150.0	17.5	5.3	4.9	7.3	1.0	110
6419	Skim milk	2700.0	242.1	104.6	13.0	124.5	17.8	1177
	Sugar	100.0	100.0	.....	.....	100.0	.....	396
	Total	.....	1988.5	306.1	54.5	1627.9	66.3	8854
	Feces	.....	93.0	46.7	14.3	32.0	17.4	604
	Estimated feces from food other than chestnuts	.....	24.2	13.2	.4	10.6	.....	120
	Estimated feces from chestnuts	.....	68.8	33.5	13.9	21.4	.....	484
	Total amount digested	.....	1895.1	259.4	40.2	1595.9	48.9	8250
	Estimated digestible nutrients in chestnuts	.....	752.4	23.9	16.0	712.5	.....	3078
		%	%	%	%	%	%	%
	Co-efficients of digestibility of total food	.....	95.3	84.7	73.8	98.0	73.8	(93.2)
	Estimated co-efficients of digestibility of chestnuts alone	.....	91.6	41.6	53.5	97.1	.....	(86.4)

DIGESTION EXPERIMENT No. 40.

Kind of food: Chestnut flour, bread, potatoes, and milk.
Subject: H. A. M. Age, 34 years.
Weight (without clothes); at beginning 130.7 lbs.; at close 129.3 lbs.
Duration: 3 days, 9 meals.

6416	Chestnut flour	900.0	821.2	57.4	29.9	733.9	21.6	3562
6418	Bread	1275.0	755.7	130.5	6.2	619.0	26.5	3365
6374	Potatoes	40.0	9.4	.9	.1	8.4	.4	40
6420	Milk	150.0	17.5	5.3	4.9	7.3	1.0	110
6419	Skim milk	2700.0	242.1	104.6	13.0	124.5	17.8	1177
	Sugar	100.0	100.0	.....	.....	100.0	.....	396
	Total	.....	1945.9	298.7	54.1	1593.1	67.3	8850
	Feces	.....	59.1	30.1	8.8	20.2	14.2	373
	Estimated feces from food other than chestnuts	.....	23.2	12.6	.4	10.2	.....	114
	Estimated feces from chestnuts	.....	35.9	17.5	8.4	10.0	.....	259
	Total amount digested	.....	1886.8	268.6	45.3	1572.9	53.1	8477
	Estimated digestible nutrients in chestnuts	.....	785.3	39.9	21.5	723.9	.....	3303
		%	%	%	%	%	%	%
	Co-efficients of digestibility of total food	.....	97.0	89.9	83.7	98.7	78.9	(92.7)
	Estimated co-efficients of digestibility of chestnuts alone	.....	98.1	69.5	71.9	98.6	.....	(92.2)

FREE ANALYSIS OF FEEDING STUFFS.

The Station officers take pains to obtain for analysis samples of all feeding stuffs coming under the law, but the co-operation of consumers is essential for the full and timely protection of their interests. Whenever any one believes that the feeding stuffs law is being evaded in any way, he is requested to notify the Director of the Station.

The Station will promptly analyze samples of feeding stuffs sold in Maine taken in accordance with the following directions, and report the results without any charge to the interested parties. Dealers and consumers are urged to avail themselves of this offer.

DIRECTIONS FOR SAMPLING.

The sample should fairly represent the feeding stuff and is best obtained as follows:

Open one or more full and unbroken packages, and mix well together the contents of each for a foot in depth, take out three cupfuls from different parts of the mixed portions of each package, pour them one over another upon a paper, intermix thoroughly, and fill a tin spice or baking powder box from the mixture. Upon paper plainly write (1) the name of the goods; (2) the name of the manufacturer; (3) the guaranteed percentages of protein and fat; (4) the name and address of the dealer; and (5) the name and address of the sender. Securely wrap the box and description of sample in paper and send by mail or prepaid express to the

Agricultural Experiment Station,
Orono, Maine.