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ORONO

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FOOD OF MAN STUDIES.

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BULLETIN No. 158.

FOOD OF MAN STUDIES.

L. H. Merrill.

The contents of this bulletin are of a somewhat miscellaneous character, although they all pertain to the food of man. With the exception of the digestion experiments with hulled corn, the work here reported was undertaken in response to demands made upon the Station and not as the result of definitely made plans. For convenience of reference the materials analyzed have been grouped into several classes, the distinctions between which are necessarily more or less arbitrary.

Tropical Foods and Vegetables.

The samples of tropical or subtropical fruits and vegetables, mostly from Florida and Porto Rico, were sent to the Station for analysis by the United States Department of Agriculture. While many of these products are not often met in the north, it is not impossible that our rapidly extending commerce will in the course of a few years place them upon our home markets. In the case of those less generally known, a few descriptive notes are added.

5007-5008. Yautia or tanier. (*Xanthosoma* sp.). This plant is a native of tropical America and closely resembles the taro, with which it is frequently confounded. The portion eaten is the tuber, which is a horizontal branch of the vertical root stock. It is one of the most important root-crops of Porto Rico, and in the interior of the Island it fills a large place in the food supply of the people. With the laboring classes the tubers are prepared for the table simply by boiling, although they are said to be more palatable when fried or baked. An average crop is from 8 to 15 tons per acre.*

Two distinct varieties were received, the flesh of one being white and the other yellow. The coating of the second was

*Barrett. The Yautias or Taniers of Porto Rico. Porto Rico Agr. Expt. Sta., Bul. No. 6.

much rougher than that of the first, and the flesh coarser in texture and more leathery. The skin was removed and only the edible part analyzed. In the white, smooth coated variety the refuse amounted to 14 per cent; in the yellow the refuse was larger, amounting to about 23 per cent.

6522. AIR POTATO. (*Dioscorea bulbifera*). This is a native of Tropical Asia. The angular tubers are aerial, being borne in the axils. Those of some varieties are said to weigh several pounds each. They are palatable and potato-like in flavor.*

Two specimens were received. These were shaped like huge, swollen beechnuts, were about 4 inches in length and weighed a little over one-fourth of a pound each. The skin was nearly black, but within the color and texture were much like that of a potato. The skin was very thin and only four per cent of the whole tuber was rejected as inedible.

6524. AVOCADO OR ALLIGATOR PEAR. (*Persea gratissima*). This is native to the West Indies, Mexico to Peru, and Brazil. "The fruits are large, more or less pear-shaped, and covered with a green or deep purple skin and containing a large quantity of a firm yellowish-green pulp, inclosing a single large seed. * * * The pulp is marrow-like and is eaten as a salad, usually with the addition of pepper, salt, and vinegar. The pulp contains an abundance of oil, which may be used for illuminating purposes, also for soap making." ***

The avocado is now cultivated in Florida, the Hawaiian Islands, and to some extent in California.† Small amounts are shipped from the tropics to northern cities and the demand is far in excess of the supply. On account of the scarcity and excellence of the fruit, prices are very high, often ranging from 35 to 75 cents for single fruits.‡

A single specimen of the fruit was received, weighing a trifle over a pound (480 grams). The pulp made up 65 per cent of the whole; the skin 11 per cent; and the seed 24 per cent. The analysis given on page 224 is that of the pulp or edible portion. It is said ** that the avocado contains no soluble carbohydrates and that it is therefore well adapted to the use of diabetics.

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*Bailey, Cyclopedia of American Horticulture, Vol. II, p. 487.
***Bailey. Cyclopedia of American Horticulture.
†Rolfe. The Avocado in Florida. Bureau of Plant Industry, Bul. 61, U. S. D. A.
‡Collins. The Avodado. Bureau of Plant Industry, Bul. 77, U. S. D. A.
**Chem. Abstracts, Vol. 2, No. 7, p. 1019.

6528. Cassava. (*Manihot* sp.). This is a plant of the milkweed family, widely grown in the tropics and to some extent in Florida, for the production of starch and also as a food for stock. For these purposes only the roots are used. These are from one to two inches in diameter and from one to four feet in length. They grow in clusters, the roots from a single plant weighing from 5 to 30 pounds, and the yield per acre averaging from five to seven tons.*

Four small roots were examined, weighing about 110 grams each. The outer skin, amounting to 4 per cent of the whole, was rejected.

6530. Cocoanut (*Cocos nucifera*). This well known fruit needs no description. The single specimen gave the following proportions of shell, meat and milk:

Shell	175.4 grams	22.53 per cent
Meat	441.0 "	56.66 "
Milk	162.0 "	20.81 "

Only the meat was analyzed.

6533. Papaya, papaw. (*Carica Papaya*). The tree is a native of tropical America, but is widely naturalized. The young fruit is cooked and eaten, while the ripe fruit is often eaten raw. According to Bailey, it is also employed as a vermifuge and a cosmetic. A remarkable property of the plant is the possession of a proteolytic ferment, capable of converting proteids into soluble forms (proteoses and peptones). Advantage is taken of this property in the preparation of meats for the table. The flesh is rolled in the bruised leaves and allowed to stand several hours before cooking, the effect being to make the meat very tender.†

A single specimen was received, weighing a little over half a pound (277.8 grams). Only 40 per cent of the fruit could be considered edible, nearly 60 per cent being removed as skin and seeds.

6534-6. Sweet potato. (*Ipomoea Batatas*). This vegetable is too well known to require a detailed description here. It seems to have been in general use by the aborigines of tropical and subtropical America and its cultivation has been greatly

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* Tracy, Farmers' Bulletin 167, U. S. D. A.

† Bailey, Cyclopedia of American Horticulture, Vol. II, p. 246.

extended. In the Southern States it now fills the place which the Irish potato takes in the North.

Three varieties were received, readily distinguished by the color of the flesh, and here characterized by the simple terms the "white" the "red," and the "yellow." The refuse (skin) from these potatoes was small, amounting on the average to about 7 per cent.

6537. Tayote or chayote. (*Sechium edule*). This is a vegetable of the gourd family, pear-shaped, deeply marked with longitudinal grooves, and having a single large seed. It was described by Hernandez in the sixteenth century and appears to have been cultivated by the aborigines for so many centuries that the wild form is no longer known. Today it is not only cultivated throughout tropical America, but it has been introduced into British India, Algeria, Australia, and to some extent into California and the Gulf States. The vegetable is said to form an acceptable substitute to the summer squash, but is of finer texture and better flavor.*

The fruits received weighed about 130 grams each, of which 95 per cent was edible.

6538. Sour-sop. (*Anona muricata*). This is the fruit of a small evergreen tree, a native of the West Indies, now introduced into southern Florida and to some extent into the Old World. The fruit varies in weight from a few ounces to two or three pounds, is dark green in color, with a soft juicy and somewhat acid pulp. Its principal use is in the preparation of cooling summer beverages.†

A single specimen of the fruit was received, weighing nearly two pounds (870.4 grams). About 71 per cent of this was edible; 21 per cent was outer coating; and 8 per cent was seed.

6539-6541. Yam. (*Dioscorea* spp.). The origin of this vegetable is unknown, but it has been long grown in the British West Indies, and has to some extent been introduced into the Southern States. It is the staple food among the blacks of Jamaica. The better varieties when roasted are said to be very palatable,‡ and there seems to be no reason why their exportation

*Cook, The Chayote, Division of Botany, Bul. 28, U. S. D. A.
†Bureau of Chemistry, Bul. 87, p. 22, U. S. D. A.
‡Div. of Botany, Circ. 21, U. S. D. A.

should not became a matter of commercial importance. Three varieties, the Amarillo, Havana and White, were examined.

6717. Egg fruit or marmalade plum. (*Lucana mammosa*). This occurs in the wild state in the West Indies and the Philippines and is cultivated in southern Florida and southern California. The fruit is about six inches long, has a russet, rough skin, and contains but a single seed. The flesh is reddish in color, soft and sweet. It has been compared to a very ripe pear, but is more luscious.*

This fruit was grown at No Name Key, Key West, Florida. Three specimens gave the following results:

Pulp	143.4 grams	82.70 per cent
Peel	12.0 "	6.92 "
Seed	18.0 "	10.38 "

6718. Sapodilla or naseberry. (*Achras Sapota*). The sapodilla is a small evergreen tree, native to tropical America. In appearance the fruit resembles a small russet apple, while the flavor is more like that of a sweet pear. It is very little known in northern markets, although its merits entitle it to a more extended use. The juice of the green fruit and the sap of the tree furnish the commercial article known as chicle, extensively used as the basis of chewing gums.†

Three fruits were received through the Division of Pomology, U. S. Department of Agriculture. These were grown at Key West, Florida. They weighed about 5 oz. each (150 grams). Edible portion 88 per cent; skin 8 per cent; seed 4 per cent.

5162. Loquat. (*Eriobotrya Japonica*). The loquat is native to China and Japan, but is much planted in the Gulf States and westward. It blooms from August until the approach of winter, and ripens its clustered fruit in very early spring. The fruit is often seen in northern markets.‡

The fruits analyzed were grown in the greenhouses of the U. S. Department of Agriculture at Washington. Thirty-six fruits weighed nearly a pound (413 grams). About 40 per cent was refuse (skin and seeds).

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*Bailey. Cyclopedia of American Horticulture, Vol. III, p. 948.

†Bureau of Chemistry, Bul. 87, p. 24, U. S. D. A.

‡Bailey. Cyclopedia American Horticulture Vol. II, p. 543.

TROPICAL FRUITS AND VEGETABLES.

Composition of fresh material. (Edible portion).

Station number.	Name.	Water.	Nitrogen.	Protein.	Ether extract.	Crude fiber.	N-free extract.	Ash.	Heat of combustion.
		%	%	%	%	%	%	%	Cal. per gram.
5007	Yautia	30.43	.64	4.00	.49	1.36	60.96	2.76	2.789
5008	Yautia	47.10	.71	4.44	.32	1.16	45.87	1.11	2.195
6522	Air potato	79.79	.30	1.86	.39	.65	16.25	1.06	.813
6523	Ajonjoli	4.17	3.79	23.69	49.39	–	18.26	4.77	6.853
6524	Avocado	77.18	.18	1.14	13.78	–	7.14	.76	1.664
6525	Bananas	60.43	.26	1.60	.15	–	31.56	1.26	1.290
6526	Bananas	78.64	.13	.81	.07	–	19.68	.80	.809
6527	Peach Bananas	70.65	.13	.81	.48	.55	26.60	.91	1.168
6528	Cassava	68.94	.25	1.59	.22	.70	27.12	1.43	1.235
6529	Cassava Bread	13.43	.04	.29	.29	1.73	83.56	.70	3.499
6530	Cocoanut	44.40	.53	3.35	29.42	2.38	19.48	.97	4.015
6531	Corn	10.92	1.41	8.81	4.08	1.93	72.79	1.47	3.993
6532	Kidney Beans	5.93	6.57	41.06	1.62	5.75	42.14	3.50	4.191
6533	Papaya	90.75	.13	.80	.10	1.09	6.32	.94	.324
6534	Sweet Potato, white	64 25	.09	.55	.46	.91	32.87	.96	1.413
6535	Sweet Potato, red	59.20	.27	1.66	.34	74	37.28	.78	1.655
6536	Sweet Potato, yellow	82.66	.16	1.09	.18	.63	14.99	.45	.692
6537	Tayote	90.40	.25	1.57	.16	1.40	5.73	.74	.380
6538	Sour Sop	80.83	.12	.78	.07	–	17.18	1.14	.745
6539	Yam, Amarillo	73.09	.21	1.32	.17	.48	24.38	.56	1.115
6540	Yam, Havana	69.23	.33	2.03	.17	.55	27.16	.85	1.156
6541	Yam, white	76.31	.34	2.14	.14	.88	19.15	1.38	.929
6542	Yuquilla	70.30	.27	1.73	.16	1.11	25.60	1.10	1.198
6713	Green Pepper	90.97	.26	1.60	.15	2.43	4.54	.31	.398
6717	Egg Fruit	51.40	.54	3.37	1.86	1.27	41.02	1.08	1.958
6718	Sapodilla	77.03	.09	.58	1.44	1.12	19.35	.48	.961
5162	Loquat	74.85	. 05	.29	–	.65	23.00	1.21	.991

TROPICAL FRUITS AND VEGETABLES.

Composition of water-free material of edible portion.

Station number.	Name	Nitrogen.	Protein.	Ether extract.	Crude fiber.	N-free extract.	Ash.	Heat of combustion.
		%	%	%	%	%	%	Cal. per gram.
5007	Yautia	.92	5.75	.71	1.96	87.62	3.96	4.009
5008	Yautia	1.33	8.39	.61	2.19	86.72	2.07	4.150
6522	Air Potato	1.47	9.18	1.94	3.24	80.40	5.24	4.023
6523	Ajonjoli	3.95	24.72	51.54	–	19.08	4.66	7.151
6524	Avocado	.80	4.98	60.44	–	31.27	3.31	7.292
6525	Bananas	.74	4.62	.43	–	91.31	3.64	3.731
6526	Bananas	.61	3.80	.32	–	92.12	3.76	3.789
6527	Peach Bananas	.45	2.82	1.65	1.88	90.57	3.08	3.980
6528	Cassava	.82	5.11	.72	2.26	87.29	4.62	3.977
6529	Cassava Bread	.05	.34	.33	2.00	96.52	.81	4.042
6530	Cocoanut	.96	6.03	52.92	4.28	35.03	1.74	.722
6531	Corn	1.58	9.89	4.58	2.17	81.71	1.65	4.482
6532	Kidney Bean	6.98	43.65	1.72	6.11	44.80	3.72	4.455
6533	Papaya	1.38	8.62	1.05	11.75	68.45	10.13	3.508
6534	Sweet Potato, white	.25	1.54	1.29	2.55	91.93	2.69	3.952
6535	Sweet Potato, Red	.65	4.08	.83	1.81	91.37	1.91	4.056
6536	Sweet Potato, yellow	1.01	6.31	1.05	3.64	86.40	2.60	3.994
6537	Tayote	2.62	16.38	1.70	14.54	59.70	7.68	3.964
6538	Sour Sop	.65	4.06	.40	–	89.60	5.94	3.889
6539	Yam, Amarillo	.78	4.90	.65	1.80	90.56	2.09	4.143
6540	Yam, Havana	1.06	6.61	.57	1.79	88.26	2.77	4.081
6541	Yam, white	1.44	9.05	.59	3.72	80.81	5.83	3.922
6542	Yuquilla	.92	5.82	.55	3.74	86.18	3.71	4.033
6713	Green Pepper	2.85	17.82	1.62	26.95	50.22	3.39	4.411
6717	Egg Fruit	1.11	6.94	3.83	2.61	84.40	2.22	4.029
6718	Sapodilla	.42	2.53	6.28	4.88	84.22	2.09	4.183
5162	Loquat	.18	1.15	–	2.58	91.46	4.81	3.940

Miscellaneous Food Products.

There are here included the analyses of a number of materials which in the table are designated "Miscellaneous Food Products" that were sent for analysis chiefly from the Office of Experiment Stations, U. S. Department of Agriculture, and the analyses of wheat, flours and other cereal products examined in connection with the work of investigation or in response to requests from private individuals who, in most instances, paid the cost of the analysis.

5156. Sanitas almond butter. Sanitas Nut Food Co., Battle Creek, Mich.

5161. Paradise nuts. (*Lecythis zabucajo*). The shells made up 45 per cent of the weight of these nuts.

5198. Seeds of Canarium commune or Java almond.

5157. French marrons glaces. Chestnuts in vanilla syrup. The analyses are of the nuts alone from which the syrup has drained, and of the same in the air dried condition.

5158. French marrons in brandy. Analyses are given of both the freshly drained and the air-dry nuts.

5159. Wallnusskerne a la vanille. Conserven-Fabrik von Wilhelm Laaff. The analyses are of the fresh nuts drained and of the nuts and syrup together.

5168. Ginger. Imperial Brand, Extra Quality, Crystallized.

6592. Desipota. Standard Food Co., Aberdeen, S. Dak. A cooked and desiccated potato.

5161. Oyster-plant or salsify. The analysis of the fresh scraped root.

5165. Cassava cakes. Park & Tilford, New York.

5169. Svea wafers. G. L. Jaquin, New York.

6441. Red Turkish wheat. Bred at the Iowa Experiment Station and distributed by the U. S. Department of Agriculture.

6932. Entire wheat flour. From macaroni wheat. Prepared by the Franklin Mills Co.

6933. Entire wheat flour. Franklin Mills Co. Purchased in Bangor.

6442. Graham flour. Received from Prof. Snyder, Minnesota Experiment Station.

5094. CORN MEAL. Prepared by Boyd Bros., Melville Station, Newport, R. I. This was a white meal, ground from Rhode Island corn.

6990. MEAD'S FLAKED RYE. Minneapolis Cereal Co., Minneapolis. "Made from the very choicest western white rye."

5199. CORN CRYSTALS. Corn Crystal Co., Worcester, Mass.

5026. EGG-O-SEE. Egg-O-See Co., Quincy, Ill. Price per package 10c. Cost per pound 11.8 cents.

6586. HAZARD'S WHEAT PROTEIN. E. C. Hazard & Co., New York.

MISCELLANEOUS FOOD PRODUCTS.

Composition of edible portion of fresh material.

Laboratory number.		Water.	Nitrogen.	Protein N×6.25.	Ether extract.	Carbohydrates. Crude Fiber.	Carbohydrates. N-free extract.	Ash.	Heat combustion.
		%	%	%	%	%	%	%	Calories per gram
5156	Almond Butter	2.25	3.61	21.66	61.50	–	11.59	3.00	7.368
5161	Paradise nuts	2.31	3.55	22.19	62.60	–	10.22	2.68	7.450
5198	Java almonds	2.24	2.48	15.50	74.37	–	4.11	3.78	7.984
5157	French Marrons, fresh	26.38	.19	1.19	.43	–	71.72	.28	3.037
5157	French Marrons, dry	18.15	.20	1.32	.48	–	79.74	.31	3.377
5158	Brandied Marrons, wet	33.88	.22	1.41	.57	–	63.85	.29	2.748
5158	Brandied Marrons, dry	21.63	.27	1.67	.68	–	75.68	.34	–
5159	Walnusskerne, wet	16.94	2.18	13.60	20.02	–	48.50	.94	6.117
5159	Walnusskerne, with syrup	31.70	1.17	7.31	9.75	–	50.70	.54	–
5163	Angelica stalks	10.47	.01	.05	.07	1.47	87.34	.60	3.417
5164	Apricots, candied	14.40	1.07	.67	.13	1.13	82.98	.69	3.183
5166	Cherries, candied	12.11	.08	.49	.15	.48	86.17	.60	3.205
5167	Citron	18.20	.01	.09	.07	.97	77.62	3.05	3.039
5168	Ginger, crystallized	12.29	.05	.34	.18	.72	86.12	.35	3.347
6592	Desipota	8.57	1.44	9.00	.15	1.75	75.32	5.21	3.606
6988	Bread fruit, flour	8.54	.49	3.06	.42	3.85	81.06	3.07	3.709
6989	Evaporated potato	8.22	1.27	7.87	1.09	2.10	77.34	3.38	3.731
5161	Oyster plant	85.37	.68	4.26	.33	1.98	6.85	1.21	.585
5165	Cassava cakes	10.32	.17	1.06	.21	1.57	85.22	1.62	3.677
5169	Svea wafers	6.48	1.74	10.87	.35	.08	78.89	3.30	3.975

6520. HAZARD'S WHEAT PROTEIN BREAKFAST FOOD. E. C. Hazard & Co., New York.

6991. UNCLE SAM'S MACARONI WHEAT BREAKFAST FOOD. Minneapolis Cereal Co. "It contains every element of absolute perfection."

5022. MACARONI. Extra Taganrok, Ancehat. Made in France for Acker Newall & Condit Co., New York.

5023. GLUTORINI. Same source as 5022. "Glutorini contains over 20 per ecnt gluten."

WHEAT, FLOURS AND OTHER CEREAL PRODUCTS.

Composition of fresh material.

Laboratory number.		Water.	Nitrogen.	Protein N x 6.25.	Ether extract.	Crude fiber.	N-free extract.	Ash.	Heat of combustion.
		%	%	%	%	%	%	%	Calories per gram
6441	Wheat	11.63	1.92	12.00	1.80	2.25	70.56	1.76	3.874
6932	Entire wheat flour	11.36	2.42	15.13	2.32	.75	69.26	1.18	–
6933	Entire wheat flour	12.33	2.27	14.18	2.07	.54	69.95	.93	–
6442	Graham flour	10.61	2.50	15.63	2.09	2.47	67.44	1.76	3.991
5094	Corn meal	11.51	1.44	9.00	4.70	1.19	72.03	1.57	–
6990	Mead's flaked rye	9.80	1.77	11.06	1.75	1.49	73.82	2.08	–
5199	Corn crystals	6.33	.96	6.00	.33	.40	86.67	.27	4.015
5026	Egg-O-See	8.03	1.55	9.69	1.77	1.47	76.66	2.38	–
6586	Hazard's wheat protein	6.99	6.69	41.81	1.23	.31	41.02	.64	4.561
6520	Hazard's breakfast food	8.53	6.41	40.06	1.04	–	49.66	.71	–
6991	Uncle Sam's food	9.72	2.37	14.81	2.18	1.60	69.85	1.84	–
5022	Macaroni	8.99	1.98	12.37	.36	.24	77.31	.73	3.973
5023	Glutorini	10.82	2.68	16.75	.73	.22	70.82	.66	4.020

Effects of Popping upon the Chemical Composition of Indian Corn.

The physical effects of heat upon the dried kernels of certain varieties of Indian corn is well known. Not only does the corn acquire a marked flavor, agreeable to the average palate, but the kernels expand enormously, while the texture is radically changed so that it is easily masticated. Some varieties of corn when thus heated swell quietly without bursting the outer covering; others, like the sweet corn, expand explosively, but without breaking the outer skin; still others suddenly burst open with sharp detonations, exposing the clear white of the starchy endosperm. The latter varieties have thus received the distinctive name of "pop-corns."

The expansive force which results in popping was formerly believed to be due to the vaporization of the volatile oils present. Storer,* however, states that corn from which the oils had been extracted with ether continued to pop well. Brewer,† Wilbert,‡ Sturtevant ** and others, attribute the popping to the rupture of the individual starch grains, due to the formation of steam. In proof of this statement mention is made of the fact that even the best varieties, if too old or too dry, will not pop unless the grains are previously soaked and then dried for 4 to 12 hours, when the popping qualities are regained.*** The effects are most marked in those varieties of corn in which there is a large amount of the dense corneous endosperm.

The chemical changes, although less manifest, are of interest. Experiments made at this Station and recorded below indicate that the physical changes are more important than the chemical. Three varieties were examined:

No. 6934. Popcorn. Purchased in Orono.

No. 6936. Yellow Canada corn. From Bangor seedsman.

No. 6938. White Corey sweet corn. Purchased in Bangor.

The popping was done over a coal furnace fire in an ordinary wire popper. While it was thoroughly done, great care was taken to avoid scorching. The analyses of these corns, before and after popping, are given in the table on the following page.

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* Stover, D. A. Bul. Bussey Inst., 3 (1904), pp. 77-79.

† Brewer, Wm. A. Tenth Census United States, Vol. 3, p. 103.

‡ Wilbert, M. I. Amer. Jour. Phar. 75 (1903), No. 2, pp. 77-79.

** Sturtevant, E. Lewis, Bul. Torrey Bot. Club, 21 (1894), p. 522.

*** Kraemer, Henry. Science, 17 (1903), pp. 683-694.

COMPOSITION OF CORN BEFORE AND AFTER POPPING.

Laboratory number	Kind of Corn.	Water.	Protein.	Ether extract.	Crude fiber.	N-free extract.	Ash.
	As analyzed	%	%	%	%	%	%
6934	Pop corn, before	10.09	12.12	4.68	2.15	69.35	1.61
6935	after	3.56	12.87	5.50	2.46	73.67	1.94
6936	Yellow Canada corn, before	9.57	10.62	5.09	1.59	71.51	1.62
6937	after	5.54	11.12	5.29	1.73	74.70	1.65
6938	White Corey sweet corn, before	9.51	11.75	5.24	2.08	69.73	1.69
	after	3.90	12.81	7.21	2.49	71.85	1.74
	Water-free						
6934	Pop corn, before	–	13.49	5.21	2.39	77.13	1.79
6935	after	–	13.34	5.71	2.55	76.39	2.01
6936	Yellow Canada corn, before	–	11.74	5.63	1.75	79.09	1.79
6937	after	–	11.77	5.60	1.83	79.06	1.74
6938	White Corey sweet corn, before	–	12.98	5.79	2.29	77.07	1.87
6939	after	–	13.33	7.50	2.59	74.77	1.81

So far as analyses go, the corn seems to suffer little chemical change beyond that resulting from a loss of water, the loss amounting to from one-half to two-thirds of the total water content. How slight these changes are is better shown when the results are calculated to a water-free basis. Similar results are given by Brewer. A determination of the water soluble carbohydrates in the corn would probably have shown a gain in every case. Such gains were found by Kraemer in sweet corn, dent, and pop corn, the gain being greatest in the case of the latter.

The Digestibility of Hulled Corn.

By treating corn with an alkali the hull or indigestible outer coating of the kernel may be so loosened that it can be easily removed. If the alkali is then thoroughly removed by washing and the product steamed, the result is the so-called "hulled corn," a very acceptable food with many. So far as the writer is aware, there are no published results which cast any light upon the digestibility of this article of diet. Sixteen experiments have been made at this Station in eight of which hulled corn and milk formed the sole articles of diet (simple diet). In eight other experiments the same foods were used with the addition of bread, butter, meat, and canned peaches (mixed diet). The details were much the same as those observed in earlier and later work in these laboratories, and need not be repeated here. The composition of the hulled corn as purchased and in the water-free condition is shown in the following table.

COMPOSITION OF HULLED CORN USED IN DIGESTION EXPERIMENTS.

Lab. No.		Water.	Nitrogen.	Protein N x 6.25.	Ether extract.	Crude Fiber.	N-free extract.	Ash.	Heat of combustion.
	Fresh	%	%	%	%	%	%	%	Calories per gram.
5171		79.67	.32	2.02	1.08	.31	15.30	1.62	.903
5172		79.73	.29	1.81	1.01	.14	15.66	1.65	.844
5178		81.32	.30	1.88	1.05	.15	14.17	1.43	.864
	Water-free								
5171		–	1.59	9.96	5.30	1.51	75.26	7.97	4.440
5172		–	1.43	8.92	5.00	.69	77.27	8.12	4.164
5178		–	1.61	10.05	5.65	.78	75.89	7.63	4.625

The experiments were carried out in the order indicated in the table which follows. For each period of four experiments

fresh samples of corn were used. It will be noted that the average results obtained with the protein in the first period are quite different from those of the third period, although both were made with the simple diet. So, too, the average results of the second and fourth periods, with the mixed diet, differ by over three per cent. How far this variation is due to differences in the corn itself it is impossible to say.

DIGESTIBILITY OF NUTRIENTS AND AVAILABILITY OF ENERGY OF TOTAL FOOD.

	Experiment number.	Subject.	Protein.	Carbohydrates.	Heat of combustion.
			%	%	%
	201	C	85.4	95.5	91.1
	202	D	78.6	96.1	89.9
Hulled corn, simple diet	203	M	85.3	98.9	91.9
	204	S	90.3	97.4	94.2
Average			84.9	97.0	91.8
	205	C	90.9	97.5	94.3
	206	D	86.6	97.2	93.3
Hulled corn, mixed diet	207	M	88.1	87.2	95.1
	208	S	91.7	98.6	95.8
Average			89.3	95.1	94.6
	209	C	78.3	96.6	90.7
	210	D	75.1	97.4	91.3
Hulled corn, simple diet	211	R	77.8	99.2	92.3
	212	S	82.7	97.8	93.1
Average			78.5	97.7	91.8
	213	C	92.8	98.8	96.3
	214	D	92.5	98.7	96.7
Hulled corn, mixed diet	215	R	91.5	99.3	96.4
	216	S	93.0	98.8	96.6
Average			92.5	98.9	96.5

The advantages of a mixed diet are here well illustrated. That the digestive power is in part an individual characteristic is also well shown, since the subject S. in every period digested the largest proportion of the protein, and in every case but one D. digested the least. The protein of the corn was less digestible than that of the milk, and when the results are calculated to the corn alone, only 61.2 per cent of the protein was found to be digested.

DIGESTIBILITY AND AVAILABILITY OF ENERGY OF HULLED CORN AND WHITE BREAD.

Summary.

	Protein.	Carbohydrates.	Heat of Combustion.
	%	%	%
Hulled corn, simple diet, average of 8 experiments	81.7	97.3	91.8
Hulled corn, mixed diet, average of 8 experiments	90.9	97.0	95.5
Hulled corn alone, average of 8 experiments	61.2	96.4	86.7
White bread, simple diet, average of 7 experiments	93.9	99.1	97.3
White bread alone, average of 7 experiments	92.6	98.9	97.5

These results are summarized in the above table in which the coefficients are compared with those obtained at another time with white flour bread. The following points may be regarded as established:

1. The digestibility of the protein and the availability of the energy of the hulled corn are very low when the corn is compared with white bread.

2. The mixed diet was much more completely utilized by the body than the simple diet.

Examination of Graham Flours.

Two samples of graham flours were recently sent to this Station for examination. One of these (Lab. No. 5191) was milled in this State under such conditions that its genuineness was beyond question. The second sample (Lab. No. 5190) bore the brand of a well known milling firm of the middle west. For some reason this second flour had fallen under the suspicion of the parties sending it, who believed it to be a "made up" flour, i. e., a low grade white flour mixed with bran. As previous complaints of inferior products of this character had reached the Station, it was thought advisable to make a comparative study of these two flours.

MECHANICAL ANALYSIS.

The samples were subjected to a mechanical analysis, two sieves being used for the purpose, one having 20 and the other 40 meshes to the inch. The coarse portion which failed to pass the 20 mesh sieve is here called bran. That passing the coarse sieve and retained by the second is here referred to as the middle product; while that passing the 40 mesh sieve is called fine flour. The results are shown below.

Lab. No.	Bran Per cent.	Middle product Per cent.	Fine flour Per cent.
5190	8	6	86
5191	7	30	63

GENERAL CHARACTERISTICS.

A microscopical examination of the brans revealed no marked differences except in the color and opacity of the various coatings. The aleurone cells were about equally abundant in the two samples. In the case of the lighter bran there seemed to be a somewhat larger proportion of the apical hairs, but this may not indicate a closer separation in one case than in the other, but rather a characteristic of the grain itself.

The most marked physical difference in these flours is in the relative size of the constituent particles. In the western flour

the bran particles are very large and the flour fine, while the amount of the intermediate product is small, amounting to but 6 per cent of whole. The home ground graham is much more homogeneous, the bran rather fine, and the proportion of the intermediate product large, forming 30 per cent of the whole, the coarser particles passing into the finer by imperceptible gradations.

The two flours were evidently from very different grains and the products show many points of dissimilarity. These characters are most readily compared in the table below.

Lab. No.	Graham.	Bran.	Middle Product	Fine Flour.
5190 Western	Dingy Texture uneven	Brown Fragments large. Diameter up to 5–6 mm. More adherent flour than with other bran.	Brown	A dirty grayish color.
5191 Eastern	Yellowish More homogeneous than the former.	Yellowish Fragments much smaller and apparently thinner Diameter up to 3–4 mm.	Distinctly yellowish, much lighter than above.	A uniformly clear and slightly yellowish product.

ANALYSIS OF THE GRAHAM FLOURS AND THE MECHANICALLY SEPARATED PRODUCTS.

Lab. No.	Kind of Flour.	Water.	Nitrogen.	Protein N×5.7.	Fat.	Crude Fiber.	N-free extract.	Ash.
		%	%	%	%	%	%	%
5190	Graham	11.73	2.47	14.08	3.04	1.88	67.25	2.02
5192	Bran	10.84	2.41	13.74	4.87	8.55	56.66	5.34
5193	Middle product	9.84	2.90	16.53	4.63	5.26	58.92	4.82
5194	Flour	11.24	2.47	14.08	2.98	1.00	69.07	1.63
5191	Graham	13.21	1.50	8.55	1.89	2.46	72.21	1.68
5195	Bran	11.43	1.92	10.94	2.13	9.07	61.16	5.27
5196	Middle product	12.60	1.78	10.15	2.55	4.81	66.61	3.28
5197	Flour	13.30	1.38	7.87	1.55	.62	75.93	.73

The preceeding analyses of the grahams and of the mechanically separated products reveal several marked peculiarities.

1. In No. 5190 the fine flour contains the same amount of nitrogen as the original graham. In No. 5191 the difference is but slight, the graham carrying but .12 per cent more than the fine flour.

2. In No. 5190 the bran is slightly less rich in nitrogen than the graham. On the other hand the bran of No. 5191 contains nearly 30 per cent more nitrogen than the graham from which it was separated.

DISTRIBUTION OF NITROGEN.

		Grams of nitrogen from 100 grams graham.	Proportion of the whole nitrogen carried by each part.
5192	Bran (.0241x8)	.1928	7.8
5193	Middle product (.029x6)	.1740	7.0
5194	Fine flour (.0247x86)	2.1242	85.2
	Calculated for whole graham	2.491	100.0
	Actual content as found	2.47	
5195	Bran (.0192x7)	.1344	8.7
5196	Middle product (.0178x30)	.5340	34.7
5197	Fine flour (.0138x63)	.8694	56.6
	Calculated for whole graham	1.5378	100.0
	Actual content as found	1.50	–

In graham No. 5190 over 85 per cent of the nitrogen of the graham is in the finer product, and 7 per cent in the middle product. In No. 5191, less than 57 per cent of the total nitrogen is in the fine flour and nearly 35 per cent in the middle product. In other words, the finer portion of the first graham is not only actually, but relatively much richer in nitrogen than the finer part of the second graham. The proportions of nitrogen carried by the brans are about the same.

It has been suggested that wheat can be so milled that the first grade flour can be removed and the remainder placed upon the market as a graham flour. Some years ago this Station made a number of milling tests with wheat and from the analyses then made it is possible to calculate the composition

of such a residual graham.* The calculation is made in the following manner:

One hundred pounds of wheat (No. 6348) yielded on milling 48 pounds of first grade flour. In the following table is shown the pounds of nutrients carried by the original wheat, from which are deducted the nutrients found in the 48 pounds of first grade flour (No. 6349). The balance represents the nutrients which would be found in the 52 pounds of the resulting "residual graham." From these weights the percentage composition of such a graham is calculated.

COMPOSITION OF A RESIDUAL GRAHAM.

Lab. No.		Water.	Nitrogen.	Protein N. x6.7.	Fat.	Crude Fiber.	N-free extract.	Ash.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
6348	Wheat, 100 lbs.....	12.80	2.06	11.74	2.53	2.46	68.35	2.12
6349	First grade flour, 48 lbs.....	6.20	.88	5.03	.46	.17	35.92	.21
	Residual graham, 52 lbs....	6.60	1.18	6.71	2.07	2.29	32.43	1.91
		%	%	%	%	%	%	%
	Residual graham.....	12.69	2.23	12.90	3.98	4.40	62.36	3.67

Since the first grade flour is rich in carbohydrates (mostly starch) its removal leaves a product (here referred to as "residual graham") richer in the other constituents than either the flour or the genuine graham. Such a product might pass undetected, although it would be poor in gluten upon which so much of the superior bread-making qualities of a wheat flour depend.

It may be stated that the composition of the suspected graham, No. 5190, does not suggest such a preparation as that noted above. If the composition of the fictitious graham be compared with that of the two grahams under examination (page 235) it will be found to be much richer in both fiber and ash than these. Wheat carries on the average 2.40 per cent crude fiber,

* Maine Agr. Exp. Sta., Bul. 97, p. 165.

and the low percentage in graham No. 5190 strengthens the suspicion that it is a made-up product, carrying a considerable proportion of low grade flour. It should be noted also that the removal of the high grade flour, poor in ash constituents would raise the proportion of ash in the residual graham (3.67) far above that found in the genuine graham (1.68).

Some of the results obtained with the western flour seem to strengthen the suspicion of sophistication. Thus, the sharp line which separates the coarser from the finer particles in No. 5190 might easily be accounted for in this way. One of the by-products in the manufacture of patent flour is known as "red dog" flour. This is frequently richer in nitrogen than the patent flour from the same wheat, but is dark in color and does not make good bread. Such a flour might be judiciously combined with bran so as to form a product closely resembling a poor but genuine graham. Attention has already been called to the fact that the finer portion of No. 5190 is dark in color while the table of composition shows it to be as rich in nitrogen as the original graham. As contrasted to this, attention is called to No. 5191, which is a guaranteed graham, the finer portion of which is less rich in nitrogen and of a lighter color than the original graham. It is fair to add, however, that the wheats in these two cases were evidently of very different quality, and it is not safe to draw too sweeping conclusions from the examination of but two samples.