Hydrogen peroxide solution, on shaking with the benzene solution of the oil and coloring matter, gave no bleaching effect. This was true in acid, neutral and basic solutions.

A solution of the colored oil in acetone was treated with a trace of water and aluminum amalgam. The color was not changed. Zinc dust and acetic acid were also without effect.

Action of Reagents on the Colored Oil.—The yellow colored oil, free from the solvent, may be rendered nearly colorless by very cautiously applying nitrogen peroxide, chlorine or bromine. The first effect is to destroy the yellow color. Secondary effects, such as causing the oil to become red-brown, are obtained by an excess of the reagent or by heating or by both.

Effect of Nitrogen Peroxide on the Constituents of Flour Other than the Coloring Matter.—Fleurent[1] found, in the study of what appears to the writer to have been over-bleached flours, that the iodine number of the oils was markedly decreased. Alway, in a private communication, states that he finds no apparent effect on the bread making qualities of numerous samples as actually commercially bleached in Nebraska.

The oil from bleached flour does not respond to the Griess test. The flour, after extracting with benzene, responds to the Griess test. The bread, after baking, contains nitrites, as found in this laboratory and as pointed out by Ladd[2]. Evidently a part of the nitrous acid has formed a relatively stable compound. Presumably a salt has been formed by the union of nitrous acid with the mineral matter of the flour.

An excess of nitrogen peroxide discolors the gluten of the flour.

Conclusion.

The minute traces of yellow color present in flour can be bleached with different to ordinary oxidation or reduction or to acids or alkalies.

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Whatever the nature of the coloring matter may be it appears to be in-such minute amounts of nitrogen peroxide that it is difficult to detect any effect on the flour other than the bleaching and the presence of traces of nitrites.

The extreme sensitiveness of the coloring matter to nitrous acid suggests that the color may be dependent on the presence of an amino group.

THE CHEMICAL COMPOSITION OF COOKED VEGETABLE FOODS. PART II.

KATHARINE I. WILLIAMS.

Received November 27, 1906.

The investigations described in the following pages, are a continuation of the work published in the *Journal of the American Chemical Society,*

[1] Northwestern Miller, December 13, 1905.

[2] Bulletin No. 72, North Dakota Exp. Station.

Vol. XXVI, No. 3. March, 1904. As there stated most of the earlier work published on this subject deals with analysis of raw foods, whereas the main object of this investigation was to gain information regarding the composition of foods as served at table. The cereals were bought at some of the best grocers' shops in Clifton; the samples of granola and farola were kindly supplied direct from Glasgow by Mr. James Marshall.

General Preparation of the Samples.

In dealing with the class of foods described below there is no refuse or waste either before or after cooking. The water used for cooking purposes was undistilled as supplied by the Bristol Water Company to the Chemical Department University College and shows about 26 degrees of hardness, chiefly due to calcium carbonate. No salt or sugar or other substance was added to the samples before or during the process of cooking.

Details as to Cooking.

PEARL BARLEY.—56.675 grams (or two ounces) of the sample were first washed in cold water, and placed on a sieve to drain, the pearl barley was then placed in a saucepan containing 1135.8 cc. of cold water, which was gradually brought to the boiling point and maintained at that temperature for twenty minutes, then allowed to cool, and the excess of water drained off on a colander.

VERMICELLI.—The first process consisted in soaking the vermicelli for an hour in cold water; it was then placed on a sieve to drain, and afterwards plunged into boiling water and briskly boiled for twenty minutes. It was occasionally stirred until quite tender, and then the process arrested by the addition of cold water; it was then ready to be drained on a colander.

SAGO (GRANULATED).—The sago was placed in a saucepan with excess of cold water and boiled for twenty minutes, after which it was drained.

ARROWROOT.—The sample used was a West Indian preparation 14.16 grams (or half an ounce) was thoroughly mixed with 70 cc. of cold water, then 283.9 cc. (half a pint) of boiling water was added, and the whole well stirred until the boiling point was reached (about 5 minutes).

BENGER'S FOOD consists of a mixture of wheat flour and pancreatic extract. This was cooked according to the directions of the maker, one tablespoonful (or about 28.37 grams) and 60 cc. of cold milk were well stirred together, then 283.9 cc. of boiling milk and water (consisting of ⅔ milk (sp. g. 1.029, and ⅓ water)) was added to the preparation allowed to stand for fifteen minutes in a warm place, and afterwards brought to the boiling point.

Patent Preparations of Wheat.

FAROLA.—This is a granular preparation of the endosperm of wheat,

and is sold in three grain varieties, fine, medium, and large. The fine variety is specially prepared for infant's food, custard, and for use in the place of arrowroot. The other two varieties can be used in puddings in the place of vermicelli and macaroni, the large grain is also useful as porridge. 19.51 grams (a tablespoonful) is added to 70 cc. of cold water and well stirred, then 283.9 cc. of boiling water is added and the whole boiled with continual stirring for ten to fifteen minutes.

GRANOLA is a whole wheat preparation; it can also be used as porridge, and is cooked by the same method as farola. Both farola and granola are prepared by Mr. James Marshall, of Glasgow.

FLORADOR is another wheat product, also in the granular form; it is sold in three size grains, and recommended for use in the making of porridge, blancmange, and for infants' foods. It is prepared by the Florador Food Co., of Glasgow and London. One tablespoonful (about 19.79 grams) was mixed with 70 cc. (a wine glassful) of cold water, and then 283.9 cc. (about half a pint) of boiling water was carefully added, and the whole boiled for ten minutes, with occasional stirring.

GRAPE-NUTS.—This food is prepared by the Grape Nut Co., and is a malted predigested preparation of the entire wheat berry, which therefore requires no cooking.

SEMOLINA is prepared from the central part of hard wheats, and is much used in the South of Europe. The semolina grains were shaken into a saucepan containing boiling water, and boiled with continual stirring for fifteen minutes, the mixture was afterwards drained over a colander to remove the excess of water.

OSWEGO.—Kingsford's preparation was selected for analysis; it is one of the few forms of maize used as food in England; a tablespoonful (or about 21.32 grams) of the flour was well mixed with 70 cc. of cold water, then 568 cc. of boiling water was added, and the mixture occasionally stirred and kept boiling for fifteen minutes.

HOMINY—a preparation of broken maize. The grains were sprinkled into a saucepan containing boiling water; and the temperature maintained with constant stirring until the grains were soft. They were afterwards drained.

QUAKER BRAND OF ROLLED OATS.—As heat is applied during the rolling process, the grains are partially cooked before coming into the market. One part of oats was slowly added to two and a quarter parts of boiling water and the mixture stirred slowly and kept briskly boiling for twenty minutes.

MOTHERS' OATS.—This preparation of oats is crushed, parched, and steam cooked before it leaves the factory. Both Quaker and Mothers' Oats are prepared by the "Great Western Cereal Co.," at Chicago.

Following the directions printed outside the packet three parts of boil-

ing water was added to one part of Mothers' Oats, the mixture stirred and boiled for two minutes over a gas stove, then the saucepan was placed inside an outer boiler containing boiling water, and cooked for fifteen minutes.

PROVOST OATS—the preparation of Messrs. R. Robinson & Sons, of Annan, is one of the best known forms of Scotch rolled oats, is also partially cooked during the process of preparation from the grain. To two parts of cold water, one part of the oats was added, as soon as boiling commenced the mixture was well stirred for ten minutes to prevent burning. Every sample was carefully weighed before and after cooking, as is shown in Table I; the price per pound of the raw substance is given, and also for the table of comparison, the percentages of water in the raw and cooked conditions.

This Table shows the great increase in bulk, which this class of foods undergo, in consequence of the absorbtion of water in the process of cooking. Taking arrowroot as an example, it was found to absorb about ten times its weight of water, sago swells up and 100 grams become 709 in the process of cooking, and the three preparations of oats behave in a similar manner.

TABLE I

	Price per pound in pence	Weight before cooking grams	Weight after cooking grams	Percentage water in raw cereals	Percentage water in cooked cereals
Semolina	3½	100	818.1	7.23	90.17
Sago	3	100	709.0	14.41	89.00
Oswego	5½	100	618.1	13.42	87.32
Vermicelli	6	100	514.2	11.84	87.14
Hominy	1¾	100	622.8	12.99	86.63
Arrowroot	16	100	1115.2	15.58	93.45
Bengers food cooked with milk	16	100	3296.0	6.75	88.30
Quaker Oats	2¾	100	1110.0	12.71	92.48
Provost Oats	2¾	100	668.1	10.08	88.44
Mothers' Oats	2½	100	924.6	14.40	89.72
Farola fine grain	6	100	842.3	12.49	90.24
Farola medium grain	6	100	850.1	11.99	89.15
Farola large grain	6	100	697.4	13.10	86.08
Florador large grain	6	100	713.2	13.08	89.45
Granola	6	100	860.1	12.87	87.40
Pearl Barley	3	100	630.9	11.68	85.01
Grape Nuts	7	...	....	7.58	....

Methods of Analysis.

DETERMINATION OF WATER.—A small portion from 10-150 grams of the cooked cereal was weighed in a flat evaporating dish, and heated from twelve to twenty-four hours in a steam and then in an air bath at a temperature not exceeding 110°. When the sample was hard enough to be ground, it was allowed to cool in a desiccator, weighed again, and reduced to as fine powder as possible in a coffee mill. A portion of the powder

was again weighed, placed in the air bath at a temperature not exceeding 110°, until the weight remained constant; from the data obtained the percentage of water was calculated. In every case at least two estimations were made. The powder was then placed in bottles with close-fitting stoppers, and used for the other determinations.

Ash.—A weighed portion of the powdered cereal was placed on a flat platinum dish when possible, otherwise on a porcelain dish. It was found by placing a lamp chimney over the dish, a sufficient draught of air was obtained to completely combust the carbonaceous residue, the dish was then allowed to cool in a desiccator before weighing. Exhaustion with water was not required. From 0.8-5 grams were used for this series of determinations, and in every case two or three determinations were made.

Nitrogen.—The Gunning method modified to include the nitrogen of nitrates, as described in "Food Inspection and Analysis," (page 63), by Albert E. Leach, was used in this series of determinations. Three, and when possible, four estimations of each substance were made.

Protein.—The protein was calculated by multiplying the nitrogen previously determined by the Gunning method by the factor, 6.25.

Starch or Carbohydrates by Direct Inversion with Hydrochloric Acid.—The starch was determined by inversion into glucose, as explained in the "Chemical Composition of Cooked Vegetable Foods[1]." The following method was tried and proved successful. A weighed portion of the cereal powder was digested with 10 cc. of hydrochloric acid (sp. gr. 1.125) and 100 cc. of water, in a flask connected with a reflux condenser, and the whole was boiled for three hours, and afterwards the solution was filtered. The filtrate was treated with basic acetate of lead, and a current of sulphur dioxide was passed through in order to precipitate any excess of lead, the liquid was filtered, and washed alumina added until no more was dissolved. It was found much time could be saved, and satisfactory results obtained, by using sodium sulphate in the place of sulphur dioxide and alumina. The solution was concentrated at 100°, and when necessary boiled with animal charcoal and a few drops of milk of lime, finally filtered before titrating with Fehling's solution. Each cubic centimeter of Fehling's solution being equivalent to 0.0045 grams of starch. Two determinations and often three were made in every case.

Woody Fiber.—The method followed in this series of determinations was that described by Dr. H. W. Wiley in "Principles and Practice of Agricultural Chemistry," Vol. III, p. 303. From 2-4 grams of the powdered substance was used in each case, in some cereals it was found necessary to first remove the fat by digestion with ether, but only when the percentage was over 2 per cent. The powdered substance was first boiled with 200 cc. of 1.25 per cent. sulphuric acid; after filtration the residue was

[1] This Journal, 26, 249.

washed with boiling water until the washings were no longer acid. It was then boiled with 200 cc. of 1.25 per cent. solution of sodium hydroxide, free from sodium carbonate, afterwards filtered into a platinum Gooch crucible thoroughly washed with boiling water, dried at 100°, cooled in a desiccator, weighed and completely incinerated. The percentage of fibre was calculated from the loss of weight. Two, and in most cases, three estimations were made.

FAT.—The fat present was extracted from the powdered substances by means of ether. From 4-5 grams were placed in a wide glass tube, the lower and narrower end of which was closed with a plug of cotton wool, and inserted through the cork of a flask of about 100 cc. capacity, containing ether, the upper end of the tube being connected with a reflex condenser. The flask was heated by boiling water, the ethereal vapor dissolving the fat as it passed over the powder into the cooled flask; fresh ether was used from time to time until a drop on evaporation left no residue; when all the soluble matter had been extracted the ether was distilled off and the residue weighed.

SULPHUR AND PHOSPHORUS.—A portion of the powdered substance was fused with a mixture of sodium carbonate and potassium nitrate, the sulphur present was estimated as barium sulphate, while the phosphorus was precipitated in the ordinary manner as ammonium phosphomolybdate; this was collected and redissolved in ammonia and precipitated as magnesium ammonium phosphate; this was again dissolved in a solution of acetic acid, reprecipitated, and ignited, and the phosphorus calculated from the amount of pyrophosphate found.

As previously stated, the object of this investigation was to obtain a clearer knowledge of the composition of cooked foods as served at table. Most of the work published on the subject deals with uncooked substances. In the raw condition great differences in composition occur, and in the process of working, these are necessarily accentuated. With cereals like the three forms of oats, farola and granola, there is no loss of substance, only an absorption of water, but with foods like semolina and hominy some of the soluble matter is lost, when the excess of water is drained off, but even then these substances show a considerable increase in weight after cooking. In the raw condition wheat shows great difference in composition, therefore it was thought interesting to analyze the three varieties of farola, the fine grain gives the largest percentage of protein, and the medium of ash and starch. It will be seen from Table III how little nutriment these foods contain, even Quaker oats gives 92.48 per cent. water, provost oats 88.44, but at the same time the percentage of woody fiber is so low, that nearly all the solid matter consists of real nutrients.

Table II gives full details of the analysis of the dried powdered foods,

showing the percentages of ash, protein, (calculated from nitrogen) woody fiber, fats, starch by difference, and by inversion. Ultimate analyses are also given for nitrogen, sulphur and phosphorus.

Table III gives the proximate analyses calculated on the materials in their natural moist condition, in order to show clearly the true nutritive value of the foods under consideration.

TABLE II

	Ash	Protein (N x 6.25)	Fat ether extract	Woody Fibre	Crude Starch[1]	Undetermined	Nitrogen	Sulphur	Phosphorus
Semolina	1.34	19.75	0.83	0.42	73.62	3.04	3.16	0.27	...
Sago	0.73	12.55	0.40	0.05	85.28	0.99	2.08	0.48	0.18
Oswego	1.11	22.70	0.16	0.07	76.41	...	3.64	0.39	0.30
Vermicelli	1.02	19.00	0.06	0.61	84.18	...	3.04	0.19	0.38
Hominy	0.61	21.07	0.72	1.20	73.88	2.52	3.38	0.36	0.33
Arrowroot	0.33	4.68	0.03	0.10	93.01	1.85	0.75	0.18	0.40
Benger's Food	4.81	18.43	22.01	1.98	59.90	...	2.95	0.41	0.37
Quaker Oats	3.32	22.06	4.30	1.26	83.04	...	3.53	0.42	0.50
Provost Oats	2.08	17.37	3.16	1.41	77.88	...	2.78	0.42	0.47
Mothers Oats	1.79	12.53	4.39	1.46	84.72	...	2.01	0.33	0.09
Farola (fine grain)	0.62	18.87	0.19	0.74	80.29	...	3.02	0.35	0.07
Farola (medium grain)	1.33	17.68	0.07	0.55	82.01	...	2.83	0.51	0.26
Farola (large grain)	0.54	17.18	0.10	1.08	79.50	1.60	2.75	1.04	0.25
Florador (large grains)	1.02	17.12	0.11	0.81	82.23	...	2.74	0.44	0.26
Granola	1.49	20.06	0.26	0.84	74.77	2.53	3.21	0.25	0.05
Pearl Barley	1.59	16.18	0.45	0.73	86.63	...	2.59	0.35	0.69
Grape Nuts	2.24	18.63	0.65	2.39	79.08	...	2.99	0.30	0.12

Proximate Analysis Calculated for the Materials in their Natural Moist Condition.

TABLE III

	Water	Ash	Protein (N x 6.25)	Fat	Fibre	Crude Starch
Semolina	90.17	0.13	1.93	0.08	0.04	7.25
Sago	89.00	0.08	1.38	0.04	0.01	9.37
Oswego	87.32	0.14	2.88	0.02	0.01	8.68
Vermicelli	87.14	0.13	2.44	0.01	0.07	10.82
Hominy	86.63	0.08	2.81	0.09	0.16	9.87
Arrowroot	93.41	0.02	0.30	trace	0.01	6.10
Benger's food cooked with milk	88.30	0.57	2.15	2.57	0.23	8.17
Quaker Oats	92.48	0.24	1.65	0.32	0.09	6.24
Provost Oats	88.44	0.24	2.00	0.36	0.16	9.00
Mothers Oats	89.72	0.18	1.92	0.45	0.15	8.70
Farola (fine grain)	90.24	0.06	1.84	0.02	0.06	7.83
Farola (medium grain)	89.15	0.14	1.91	0.01	0.06	8.89
Farola (large grain)	86.08	0.07	2.39	0.01	0.15	11.06
Florador	89.45	0.10	1.80	0.01	0.08	8.67
Granola	67.40	0.18	2.52	0.03	0.10	9.42
Pearl Barley	85.01	0.24	2.91	0.07	0.10	12.98
Grape Nuts	7.53	2.07	17.26	0.60	2.20	73.08

[1] Determined with Fehling Solution after hydrolysis with dilute hydrochloric acid.

Table IV, calculated from Table III, has been added at the suggestion of Professor Francis, so that dietaries can be easily computed. All dietary standards must be based on the quantity of nutrients needed by each individual or class, the general assumption being that the body must be supplied with sufficient protein to replace all the nitrogenous substances consumed in the body, and enough energy to supply the demand for heat, muscular and other work. It is stated in Bulletin No. 42, U. S. Department of Agriculture (office of Experiment Stations), page 7, "as the chief function of the fats and carbohydrates is to serve as fuel, it is of more importance they should be sufficient in amount than that they should be in definite relative proportion to each other. The ratio between the amount of protein and the other organic nutrients in the food is called the nutritive ratio. Since the fuel value of fat is about two and one-fourth times that of carbohydrates or protein, the quantity of fat is multiplied by 2¼ and added to the carbohydrates, the nutritive ratio being obtained by dividing this sum by the amount of protein. If the fats and carbohydrates are very largely in excess of the protein, the nutritive ratio will be large (wide) becoming smaller (narrower) as the relative amount of protein increases.' Professor Atwater gives as the evidence obtained from the study of American dietaries.

	Nutritive ratio	
Woman with light muscular work	1 : 5.5	
Man without muscular work	1 : 5.6	
Woman with moderate muscular work	1 : 5.6	
Man with moderate muscular work	1 : 5.8	White

TABLE IV

Nutrient		Ratio	Heats of combustion Calories
Semolina	1	3.8	383.7
Sago	1	6.8	444.3
Oswego	1	3.4	513.9
Vermicelli	1	4.4	544.1
Hominy	1	3.6	628.2
Arrowroot	1	20.3	262.4
Bengers food (cooked in milk)	1	6.5	662.1
Quaker Oats	1	4.2	353.3
Provost Oats	1	4.9	484.5
Mothers Oats	1	5.1	460.5
Farola fine grain	1	4.3	408.5
Farola medium grain	1	5.2	443.7
Farola large grain	1	4.3	552.1
Florador	1	4.6	430.2
Granola	1	3.7	491.3
Pearl Barley	1	5.7	550.6
Grape Nuts	1	4.3	3059.8

In the third column of Table IV the first value is given in calories per kilogram. The values are calculated by the use of Runer's factors, 4.1

calories for a gram of protein, the same for a gram of carbohydrates, and 9.3 per gram of fats.

It will be observed that arrowroot gives the widest nutrient ratio, 1 : 20, showing how largely starch enters into its composition; it is also an expensive food, costing sixteen pence per pound. Fine grain farola is prepared as a substitute costing only sixpence per pound, with a nutrient ratio, 1 : 43, and ought to prove a nourishing food for ordinary invalids.

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THE AVAILABLE HYDROGEN OF COAL.

BY S. W. PARR.

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The volatile constituents of coal being the subject of special attention on the part of the Illinois State Geological Survey the following study has been made in connection with that work.

The available hydrogen of coal is that part of the total hydrogen which may enter into combination with oxygen for the production of heat. The carbon, sulphur and available hydrogen constitute the actual combustible matter. While methods for the determination of carbon and sulphur are direct and accurate, there is no direct method applicable for available hydrogen.

The usual procedure is one of calculation, and it is indicated in Dulong's formula for determining the heat value from analytical data thus, $\text{calories} = 8080\,C + 34460\left(H - \frac{O}{8}\right) + 22.50S$. The accuracy of the factor for the available hydrogen, therefore, depends upon the accuracy attending the determination of oxygen. But the oxygen factor is subject to error. It is determined by difference and includes, therefore, the sum of all the errors that may have attended the work on the other constituents. This is of considerable moment in the case of coal high in sulphur. If the sulphur is all in the pyritic form, and if we assume the iron only to be an ash constituent, the ash will be too high by reason of the oxidation of the iron, the added oxygen increasing the ash factor by 3/8 of the sulphur constituent. This error falls upon the oxygen making the percentage of that element too low or too high, depending on the basis of calculation. Nor can this difficulty be easily obviated by correcting the ash, since coals are very frequently met with high in sulphur and practically free from iron.

In the results published by Lord & Haas[1] on 50 coals of the Pennsylvania and Ohio region the results from calorific determinations compared with calculations by the Dulong formula were in such close agreement as

[1] Trans. Am. Inst. Eng., Vol. 27.