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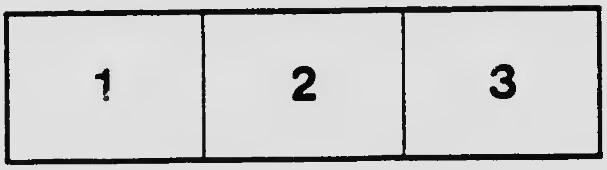

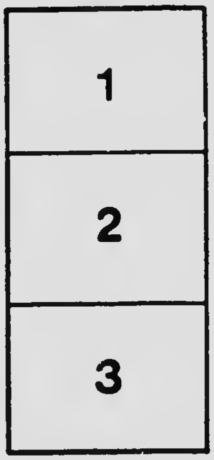

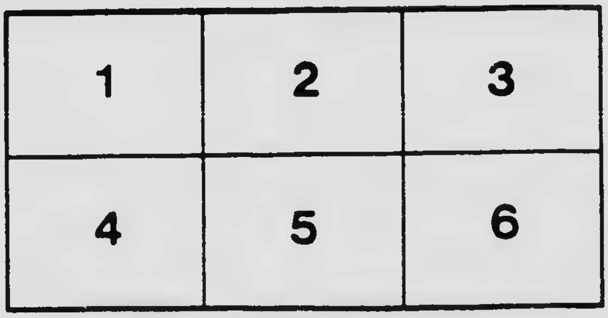

LABORATORY

OF THE

INLAND REVENUE DEPARTMENT,

OTTAWA, CANADA,

1902.

BULLETIN No. 84.

CEREAL BREAKFAST FOODS.

LABORATORY

OF THE

INLAND REVENUE DEPARTMENT

BULLETIN No. 84

CEREAL BREAKFAST FOODS

OTTAWA, December 17, 1902.

W. J. GERALD, Esq.,
Deputy Minister of Inland Revenue.

SIR,—I beg to transmit herewith a report by Mr. A. McGill, M.A., assistant to the chief analyst, on Cereal Breakfast Foods, together with a tabulated statement of the analytical results obtained by him in this laboratory, with the assistance of Miss E. Davidson, Miss S. E. Wright, Mr. Alphonse Lemoine and Mr. J. G. A. Valin. The statement also shows the nature and origin of the different samples examined.

I have the honour to be, sir,

Your obedient servant,

THOMAS MACFARLANE,
Chief Analyst.

LABORATORY OF THE INLAND REVENUE DEPARTMENT.

OTTAWA, December 10, 1902.

THOS. MACFARLANE, Esq., F.R.S.C.,
Chief Analyst Inland Revenue Department,

SIR,—I beg herewith to submit a report of my work on Breakfast Foods.

These samples, as you are aware, were not collected and examined because of any suspicion regarding their wholesomeness or genuineness, for they were believed to be as their analysis proves them to be, nutritious and palatable foods. In view, however, of the high prices at which they are sold, and of the extravagant claims put forth by their manufacturers as to their digestibility, nutrient power, &c., there exists a wide-spread demand for information as to what they really are, and how much of all the value claimed for them they really possess.

The use of oatmeal, cracked wheat, cornmeal, &c., as materials for porridge, goes back as far as history, but the use of so-called prepared foods, is a thing of very recent date. Most of these foods claim to be partly or wholly cooked, and in view of the practical indigestibility of uncooked starch, it is matter of high importance that the purchaser should know just how much of truth there is in the claim. The further inquiries as to relative richness in nitrogen, digestibility of the nitrogenous material, proportion of salts, &c., are scarcely of secondary importance, particularly in cases where the manufacturer promises a 'perfect food,' i.e., a food capable of satisfying every demand of the system.

Unfortunately our knowledge of the different forms in which nitrogen occurs in cereals is far from perfect; and the excellent work done in recent years by chemists in this field, has been achieved by methods of operation too involved and too time-consuming to render them available in the laboratory of the food-analyst. The points of difference in quantity and quality which have been demonstrated, among others, by Osborne and Voorhees (*See* Journal Am. Chem. Society, 1893, and succeeding years) between the proteids of different cereals, have doubtless a very important relation to the values of these cereals for human food. But the differences in question are not available by any practicable methods of working, for the use of the analyst. It is even too much to say that our knowledge of the carbo-hydrates of cereals approaches completeness; while the relative values of these materials in nutrition is still another aspect of the question, that must be dealt with by the physiological chemist.

Available methods for the proximate analysis of cereals, enable us to discriminate so far as indicated in the analytical tables furnished herewith. The work might even be carried somewhat further, since fairly well accredited methods for the estimation of pentosans, among the carbohydrates, and amidic bodies, among the azotized components, have been worked out. Pressure of work has, however compelled me to leave this task less complete than I should wish.

The earliest work on the examination of *Prepared Cereal Foods* which has come under my notice, is that of Slosson, published in Bull. 33 of the Wyoming Experiment Station in 1897. In addition to most of the usual determinations, Mr. Slosson has estimated *phosphorus*, and the following limit results for phosphorus and calorific values, are of interest:

—	Phosphorus per cent.			Calories per Gram.		
	Max.	Min.	Mean.	Max.	Min.	Mean.
From 21 samples of prepared cereal food.	·447	·153	·321	4,756	3,660	4,326

The highest content in phosphorus, as well as the highest calorific value, are found in preparations of oatmeal, so that the popular preference for this cereal, seems to be warranted on scientific grounds.

In Part 9, of Bull. 13—U. S. Department of Agriculture, 1898, Dr. Wiley has published the results of analysis of 48 samples of Breakfast Foods. The following summary of his results has both interest and value (See pp. 1345—1349, op. cit.):—

MEAN RESULTS ON CEREAL FOOD PRODUCTS.

From Bull. 13, part 9,—U. S. Dept., of Agriculture.

Class of Food.	Moisture.	Fat.	Ash.	Crude Fiber.	Total Nitrogen.	Carbohydrates other than fiber.	Digestible Proteids.	Calories of Combustion.
Indian corn products (mean of 6 samples)........	12·33	0·58	0·66	0·67	1·27	78·51	24·86	4,300
Wheat products (mean of 14 samples)........	10·08	1·80	1·55	1·48	1·90	75·62	62·47	4,489
Oat products (mean of 7 samples).	7·66	7·46	1·79	1·20	2·45	67·61	51·09	4,671
Starch and tapioca (mean of 7 samples)........	11·29	0·03	0·14	0·13	0·06	88·15	....	4,160
Noodles, spaghetti and macaroni (mean of 9 samples)...........	9·66	0·42	0·78	0·56	1·92	77·12	80·53	4,342
Barley...........	10·92	0·89	0·86	0·67	1·20	80·35	30·20	4,365
Miscellaneous (4 samples).......	6·41	1·05	1·06	0·99	2·05	78·68	52·04	4,460

Dr. Wiley has explained to me that the results entered in the column headed 'Digestibles Proteids,' were obtained by working with Wilson's modification of Stutzer's pepsin method—This is fully described in Jour. Soc. Chem. Industry, 1891, p. 118.

The calorific values given in the last column, were found by actual combustion. When, however, the proximate analysis of a cereal is given, the calorific value (in calories per gram) can be very closely ascertained by using the following factors:—

Pentoses, lactose, crystalized dextrose and fructose=3,750 calories per gram.

Sucrose, maltose and anhydrous lactose=3,950 calories per gram.

Starch and cellulose=4,200 calories per gram.

Proteids=5,900 calories per gram.

Fat (Ether Extract)=9,300 calories per gram. Bull. 13—part 9,—U. S. Dept., of Agriculture—pp. 1245—1249.

For the purpose of calculating the calorific value of these cereal foods, the numbers given in the accompanying analytical tables may be thus written:—(mean results are used.)

Malt Breakfast Food—

	Per cent.		
Moisture............	9·99		
Fat................	1·03	× 93 =	95·8
Ash................	0·56		
Proteids............	12·44	× 59 =	734·0
Fiber..............	1·05	}	
Dextrin............	3·24	} × 42 =	3,265·0
Starch (difference)....	71·69	}	
	100·00		4.094·8 calories per gram.

The Calorific values in the following table are calculated after the manner shown.

Sample.	Moisture.	Fat.	Ash.	Proteids — Nitrogen × 6·25.	Crude Fibre.	Dextrin	Starch — By difference.	Calories per gram.	Material Soluble in cold water.
	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.
Malt breakfast food....	9·99	1·03	0·56	12·44	1·05	3·24	71·69	4004·8	13·00
Force	11·92	1·27	2·75	11·56	2·60	14·48	55·42	3845·1	29·60
Malta vita	11·10	1·25	3·00	9·88	3·15	9·26	62·36	3840·3	30·88
Grape nuts...............	9·43	0·58	1·64	12·00	2·03	24·87	49·45	3968·9	49·50
Life chips...........	9·90	1·69	2·60	9·60	2·90	12·16	61·06	3925·9	19·30
Ralston breakfast food..	13·02	1·54	0·78	12·50	1·68	2·62	67·86	3911·7	7·50
Rolled oats..........	11·21	7·21	1·68	12·79	3·14	3·58	60·49	4242·2	6·19
Oatmeal.............	10·84	6·91	1·14	13·00	4·28	....	63·83	4270·6	3·85
Peameal...............	10·40	1·33	2·62	27·50	1·36	....	56·73	4132·7	17·75
Cornmeal common.......	13·12	5·21	1·42	10·25	3·50	....	66·50	4029·2	6·30
" golden.......	14·90	2·01	0·58	8·94	1·18	....	72·39	3804·3	2·90

One is often asked the question 'Which of all these breakfast foods is the best value from the point of view of nutrition?' While a categorical reply to such a question is not possible, the data contained in this table make a conditioned answer quite possible. Provided that the article is served up in such a way as to render it fully digestible, then from a consideration alone of the energy that can be derived from it, there is very little to choose between them.

The extremes in calorific value are found respectively in oatmeal (4270·6) and golden cornmeal (3804·3). The difference between these values is only 466·3 calories, or 11 per cent. Both of these foods are sold in the 'uncooked' state. The claim of the manufacturers of the cooked, or malted foods is that by the process to which they have been subjected, the 'insoluble starch is converted into soluble maltose and dextrin'. The last column of the above table shows to what extent this rendering the starch soluble has occurred. Thus, we find oatmeal to yield but 3·85 per cent, to cold water, while several of the prepared foods yield 20 per cent, or more to this solvent.*

*The following attempt to explain the essential principles of nutrition in non technical language, has been made in deference to the advice of a friend, of whose opinions I entertain a high regard. I am fully aware of the dangers incident to an explanation of scientific matters by the analogical method, and I may have pressed the analogy too far in some points, I believe, however, that all that I have said is materially accurate; and shall be sufficiently rewarded if I have put the subject in such a form as to make it intelligible to non-scientific readers, so as to interest them in it, and induce them to make themselves acquainted with the more strictly technical terms in which alone the subject can be discussed to advantage.

Work is done whenever the tendency to rest is resisted. In this sense mere living implies work, for the beating of the heart and the flow of blood in the vessels means effort, although such effort is not conscious. The power to do work is spoken of as energy, and wherever work is done, energy is being expended. A locomotive engine in movement is an example of work being performed, and energy being expended. A man running, or walking, or even sitting still, so long as he is alive, is equally an instance of work being done, and of energy being expended. When we see an engine in movement, we know that fuel is being burnt within it; so when we see a man in movement, we know that fuel (food) is being consumed (digested) within him. The food of

Of course the chief object sought in *boiling* porridge, is to render the starch soluble; and where conditions make it difficult, or impossible to properly cook one's porridge, there is doubtless an advantage in using a material that has already undergone some change in this regard. Whether or not the high prices at which these foods are sold are sufficiently warranted by the saving of fuel and time, under ordinary conditions of domestic life, is a question to be solved by each housekeeper for himself.

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the engine (coal or wood) must not only be put into it, but must undergo combustion (oxidation) in the fireplace. So the fuel (food) of man must not merely be taken into his body, but must there undergo combustion (digestion) in order to furnish the energy necessary to do work. The food of man need not necessarily be taken in from *without*, since his own fat, may be consumed within him, just as the fireman of an engine, when coal is scarce, may break up the woodwork of his cab and burn it with his cushions and even his clothing in order to keep his engine going. I[illegible]dient that such a state of things could not last long; and so too of the consump[illegible]man's own tissues. He wastes away, and becomes mere skin and bone, and [illegible]s.—(ceases to go.) Not every kind of material is suitable for the nutrition of [illegible]otive engine, and there are degrees of value even among those forms of matter which may be used as fuel. So with man. Certain forms of matter are capable of being burnt within him to advantage, and long experience has proved that his energy is best derived from *fats*, *carbohydrates* and *proteids*, just as the energy of the engine is best derived from *coal*, *wood* or *oil*.

Energy may show itself in other ways than by movement; and the most notable of these other ways, is by the production of heat. A movement of what we call electricity (another form of energy) is constantly taking place in our trolley wires. When the wire breaks, and the free ends touch the roadway—which resists the passage of the electricity—tremendous heat is developed; if to the free ends of the wires carbon rods are attached, the heat and light produced constitute the arc-lamps so commonly employed in street lighting. The heat of the locomotive boiler is an expression of the energy produced by the burning of the fuel; and the heat of man's body—which is always about 98° Fah., although the temperature of the air round about him may be below zero—is an expression of a part of the energy produced by digestion of his food. It would be possible to measure energy by taking, for example, the amount that must be expended against the force of gravity in lifting a weight of one pound through a height of one foot; but in the study of dige[illegible]n it is much more convenient to measure energy in terms of heat. The heat requi[illegible]o raise 1 gramme (= 15·5 grains) of water through 1 degree Centigrade (= $1\frac{4}{5}$° Fal[illegible]s taken as the unit of energy, and is known as a (small) *calorie*. The energy that can be produced by the complete combustion (digestion) of 1 gramme of any kind of foodstuff may then be set down in Calories; and this has been done for the different cereal foods described in this bulletin. Just as the combustion of [illegible] ton of coa[illegible] an engine may produce more energy than the combustion of an equal [illegible]ight of wood, so the digestion of a gramme of fat produces, in the human body, a greater amount of energy than the digestion of a gramme of sugar or starch or white of egg or lean beef. Expressed in calories, the energy producing power of common foods is as follows :—

1 gramme of the dry substance—

Fat (average for various fats)...................	9·3	calories.
Proteids (" " proteids)................	5·71	"
Carbohydrates (average)	4·1	"

Of course, any failure to burn the coal completely to ashes in the engine will result in a reduction of the energy derivable from a given weight of it; and just so, the failure to completely digest any part of our food means a reduction of the energy which we might derive from it. Now the possibility of completely burning the fuel in an engine depends partly on the nature of the fuel itself, and partly on the peculiarities of the

There is, however, another point of view from which these foods may be regarded, viz: their content in proteid matter. In this respect peameal excels them all. There is however good reason to believe that the proteids of the pea and bean, and of leguminose in general, are less easily digested by man than are the proteids of the cereal grains proper. Among these oatmeal takes first rank, but several of the prepared foods stand very well in this regard. If we take into account the mineral matter (ash) which

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engine. In a similar way the possibility of completely digesting our food depends partly on the character of the food and the way it is cooked, or otherwise prepared; and partly upon the personal idiosyncrasy of the man himself. Whatever escapes digestion is not only useless, but in most cases harmful, since it consumes energy in the effort to ingest it and to egest it; just as stones in coal cause not merely a negative harm, but a positive loss since they take up heat which would otherwise go to making steam.

It may be accepted as true that, under favourable conditions, fats (*e.g.* butter, beef and mutton fat, lard, cotton seed, olive and other oils, &c) and carbohydrates (*e.g.* starch, sugars, dextrin, &c.) can be completely burnt (digested) in the body, and therefore the number of calories quoted per gramme, represents an amount of energy that can really be obtained from them, whether burnt outside of the body, or digested within it. In the case of proteids (*e.g.* lean meat, egg, casein of cheese and milk, gluten of flour, &c.) on the contrary, the digestion within the body is never so perfect as to secure all the energy that would be derived from perfect combustion of these substances outside of the body. Careful experiments have shown that whereas 5·71 calories measures the energy per gramme of proteids fully oxidized outside of the body, the energy obtained from their digestion within the body varies from 3·8 to 4·4 calories.

This is because of the peculiar character of proteids in relation to nutrition, and requires explanation.

We need more than energy to keep any machine going. The parts of the machine wear out, and the further supply of energy producing substance (fuel) to drive it, can only result in destroying the mechanism. It must go to the repair shop. The human body has its own repair shop within itself, and it is from the proteid matters of our food that repairs to the body tissues are made. The blood is the circulating fluid by which this structural material is carried to the parts where it is wanted, and by which also, the debris, or worn out tissue, is got rid of. The special organs which eliminate this waste tissue are the lungs, the kidneys, the skin and the bowels; while the organs which immediately supply new tissue—forming material to the blood are the lacteals (of the small intestine) and the lymphatic duct. The worn out proteid material is largely got rid of as urea, uric acid and other substances, which still contain latent energy, thus accounting for the apparent loss of energy occurring in the digestion of proteid foods.

Cereals, as the analytical numbers in the tables prove, contain all the substances necessary for nutrition, i.e. proteids, fat and carbohydrates; but these are contained very disproportionately. (It must not be forgotten that mineral matter is needed in a complete food; this also is found in cereals.) Whole wheat may be taken as having the following average composition :—

Proteids	12·3
Fat	1·7
Carbohydrates	67·6
Mineral matter	1·8
Water	14·0
Cellulose	2·6

Cellulose we must count as waste in food. It is the substance of which wood consists and contains much energy, but the human organism is not able to make use of this energy, in other words, cellulose is indigestible. May it not be that proteids and carbohydrates and even fat exist, which like cellulose, contain energy that the human system is no less necessary to complete nutrition, we find marked differences among these foods. If one were to live entirely or principally upon these foods, it would be very necessary to take account of this. Finally, on account of its very high energy factor, we may lay stress upon the content of fat ; and here also oatmeal stands in the first place.

On the whole, I am of opinion that as a well balanced material for porridge, these analytical results justify me in claiming a very high, if not the highest place for oatmeal, and especially in the form of rolled oats.

Recognizing, however, as I do, that our knowledge of the intimate character of the components of cereals, and of their relative digestibility, is yet far from complete, it would be presumption in me to pronounce judgment in an unqualified way, in this matter.

In an appendix to this report I have put on record a considerable amount of work, which must be regarded as a contribution towards the development of a fuller knowledge of this highly important subject.

I have the honour, to be, Sir,

Your obedient servant,

A. McGILL,

Assistant to the Chief Analyst.

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cannot utilize? The answer is undoubtedly, yes! And even among proteids, &c., that are digestible, and hence available for food, degrees of digestibility exist. The value of a food stuff is therefore not dependent merely upon its content of proteid or carbohydrate or fatty matter, but also upon the digestibility of such matter. Pea flour contains fully double the proteid matter of wheat flour, but is not on that account twice as valuable for human food. Almonds and other nuts contain still more proteid matter, but we should soon find our digestion seriously disturbed if we tried to live on almonds. Whoever shall discover a method of preparing nuts, beans and peas, so as to render them easily digestible will confer a great boon on humanity. There are similar differences in the digestibility of carbohydrates. Cellulose (woody fiber) and sugar are both carbohydrates ; but while the latter is a valuable food, the former has no value. Starch is a carbohydrate, and raw starch can be slowly and with difficulty it is true, digested. Its value is immensely increased by cooking. The various processes of cooking starch have all for their object, the increase of its digestibility ; and this is effected by converting it, more or less completely, into the substances known as *soluble starch*, *dextrin*, *maltose*, *dextrose*, &c. No doubt these substances have a varying value for the human animal, among themselves ; but further study of this interesting subject must be left to those who care to give time to it. I may mention Mandels' translation of Hammarsten's Physiological Chemistry (John Wiley & Sons, New York, 1900) as a reliable and very readable presentation of the subject.

A. McG.

APPENDIX TO BULLETIN ON CEREAL FOODS.

At the meeting of the American Association of Official Agricultural Chemists, held at Washington in 1900, it was decided to make a systematic effort to outline methods for the examination of foods. The subject, cereal products, was allotted to me; but I was not able, during the following year, to prepare any work worthy of presentation to the association. During the last six months I have taken advantage of the opportunity offered me by the collection of breakfast foods, and their submission to me for analysis, to carry on some research work in connection with this subject; and I presented a provisional report upon the subject of cereal analysis to the Washington meeting this year, although I was not privileged to be personally present at the discussion. This provisional report was based upon the work given in the appendix following; and although far from exhausting the subject with which it deals, I trust that it may do something towards aiding food analysts in this difficult and exceedingly important department of our work.

A. McGILL.

December 10, 1902.

PREPARATION OF THE SAMPLES.

In the work described in the sequel, finely ground samples (flours) were not further prepared than by thorough mixing. Samples, like most of the breakfast foods, which occur in granules or in flakes, were passed through a mill several times, until about 75 per cent of the material was fine enough to pass through a sieve of 1 mm. mesh, while the whole passed through a 2 mm. sieve. The following numbers illustrate the degree of fineness obtained :—

	2 mm. sieve. p.c.	1 mm. sieve. p.c.	0·5 mm. sieve. p.c.
A sample of 'Grape nuts'	100	72	18
" 'Life chips'	100	74	21
" 'Malta Vita'	100	71	25

DETERMINATION OF MOISTURE IN CEREALS.

Two methods of working are evidently available, viz.:—

1. By loss of weight on exposure of the sample to a dessicating atmosphere.
2. By absorption of moisture in some hygroscopic substance contained in a weighed tube.

The last may be called the 'positive method.' It has the disadvantage of requiring more time and labour in its execution, since each sample must be operated on independently. It has the merit of enabling the volatile matters which escape on heating the sample to be separated by using absorbents of special character. This method has not been examined, but will be investigated as leisure permits.

The results obtained by the 'method of loss' have been studied. The loss of weight is not necessarily water only. Gaseous products, other than vapour of water, may come off under the influence of heat. These may include carbon dioxide and hydrocarbons, especially if the temperature is allowed to rise much above 100°. It would be better to describe the result of this treatment as 'Loss of weight on drying'; or volatile matter lost at the temperature of the experiment.

Query 1.—Do cereals continue to lose weight by prolonged exposure to hot air?

A sample of Strong Bakers' flour was exposed at 95° C. to a current of air—used from 1 to 2 grammes.

		Loss of weight. After 7 hours.	After 22 hours.	
Flour	(a)	13·27	12·47	per cent.
	(h)	13·10	12·60	"
	(c)	13·10	12·55	"
	(d)	12·90	12·40	"
Mean		13·09	12·50	"

Inference.—When flour is heated for many hours in air at 95° C. a point is reached beyond which it begins to increase in weight.

On exposing this sample at 105° in an atmosphere of dry coal gas for three hours, the loss of weight was—(a) 13·7; (b) 13·9; mean=13·8 per cent.

QUERY 2.—Would a lower temperature than 95° serve the purpose of drying in air?

The same sample (Strong Bakers' flour), together with samples of 'pastry flour,' 'corn starch' and 'Force'—a prepared cereal food—were suhmitted to a current of air at 70° C.—(2·5 grammes on watch glasses):—

Time = 15 hours.

Strong Bakers' flour	(a)	11·04	=11·06 per cent.
	(h)	11·08	
Pastry flour	(a)	12·48	=12·68 "
	(h)	12·88	
Corn starch	(a)	10·48	=10·62 "
	(b)	10·76	
Force	(a)	10·28	=10·48 "
	(h)	10·68	

On further subjecting these samples to a temperature of 105°, in air, the loss of weight was as follows:—

Strong Bakers' flour	(a)	13·76	=13·52 per cent.
	(b)	13·28	
Pastry flour	(a)	14·32	=14·30 "
	(b)	14·28	
Corn starch	(a)	12·36	=12·24 "
	(h)	12·12	
Force	(a)	11·36	=11·50 "
	(b)	11·64	

Inference.—An exposure of 15 hours in air at 70° C. does not thoroughly dry cereals.

QUERY 3.—Would it be possible to obtain the maximum *loss of weight* hy weighing at intervals and noting the time at which the samples ceased to lose weight?

The above samples were exposed on watch glasses in a current of air at 105° and weighed at intervals of *one hour* until maximum loss of weight was obtained.

Strong Bakers' flour	(a)	13·68	=13·72 per cent.
	(b)	13·76	
Pastry flour	(a)	14·24	=14·22 "
	(b)	14·20	
Corn starch	(a)	12·16	=12·26 "
	(b)	12·36	
Force	(a)	12·12	=12.06 "
	(b)	12·00	

Unfortunately, the only one of these samples which was dried in coal gas, is the first. It gave 13·8 per cent loss, under these conditions.

Inference.—It is probable that a very close approximation to accuracy would result from weighing at fixed intervals of one hour, and accepting maximum loss of weight at 105°, in air, as the datum wanted.

For the following study, which is in the main corroborative of the foregoing, six samples of cereal foods were chosen.

Quantities of 2·5 grammes, on watch glasses, were exposed at 100° C., to an atmosphere of dry coal gas.

—	Loss of Weight.					
	At 100°.					At 110°
	2 hours.	4 hours.	8 hours.	10 hours.	16 hours.	4 hours.
Malt breakfast food, No. 17850.	9·28	9·80	10·12	10·24	10·48	10·52
Rolled oats, No. 23333(*b*).	10·52	....	10·80	10·92	11·08	11·08
Ralston breakfast food, No. 20230. ...	11·64	12·08	12·24	12·40	12·60	12·60
Force (special sample)...	13·68	14·12	14·28	14·40	14·56	14·56
Malt breakfast food, No. 20225(*b*).....	9·20	9·76	10·04	10·16	10·32	10·36
Grape nuts, No. 22034(*b*).......... ...	7·56	8·16	8·52	8·68	8·88	9·00

The figures in the last column give the loss of weight from raising the temperature to 110° for 4 hours longer; and indicate that drying is complete at 100° C. in 16 hours. The full time of 16 hours appears to be necessary at this temperature. An error of nearly one-fourth of one per cent would result from taking the weight after 10 hours, as final.

Other portions of 2·5 grammes of these same samples were used in the following work. Exposure at 95°–96° in a current of air, for varying periods, gave these results:

—		Loss of Weight.				Maximum Loss of Weight.	Loss in Coal Gas at 100°.
		1 hour.	2 hours.	19 hours.	21 hours.		
Malt breakfast food (17850)........	(a)	9·20	9·60	10·00	....	10·00	10·52
	(b)	5·80	9·40	9·88	... .		
Rolled oats (23333*b*).	(a)	10·24	10·48	10·56	... .	10·56	11·08
	(b)	10·48	10·52	10·44	....		
Ralston breakfast food (20230).. ..	(a)	11·16	11·44	12·12	. .....	12·24	12·60
	(b)	11·28	11·64	12·24	.. ..		
Force (special)..........	(a)	13·24	....	14·24	....	14·24	14·56
	(b)	13·44	13·72	13·72	13·84		
Malt breakfast food (20225*b*)... ...	(a)	8·96	9·88	9·88	....	9·88	10·36
	(b)	9·48	9·64	9·76	9·76		
Grape nuts (22034)................	(a)	7·04	... .	8·36	....	8·56	9·00
	(b)	7·72	8·08	8·20	8·56		

Inference.—From these results one is compelled to conclude that even 21 hours at 96° does not fully dry cereals, or that the point of drying has been passed before the expiration of this time, and increase of weight (by oxidation) has begun to take place. This is consistent with experimental work already recorded.

The following work further illustrates the fact that attempts to dry cereals in air, at 98° to 100°, fail to drive off all the volatile matter, or permit of oxidation to such an extent as to show less than the true percentage of volatile matter, when this is calculated from apparent loss of weight:—

'Malt Breakfast Foods.'	Coal Gas at 105° for 3 hours.	Air at 98° for 20 hours.	Difference
No. 4,309	10·56	9·70	0·86
" 17,850	9·67	8·95	0·72
" 21,232	8·09	7·45	0·64
" 22,040	9·59	9·15	0·44
'Force.'			
No. 4,308	11·40	8·94	2·46
" 17,427	10·65	9·85	0·80
" 17,851	11·25	8·95	2·30

Query 4.—What is the amount of unavoidable experimental error in the method of drying in coal gas?

Duplicates already quoted show that the differences obtained in these may be very large when the drying is done in air. The following duplicates were worked as nearly as possible under like conditions, in dry coal gas:—

DUPLICATES; *loss in 2·5 hours at 110°.*

'Malt Breakfast Food.'		Difference.
No. 4,309	11·00 and 10·56	0·44
" 17,850	10·10 " 9·67	0·43
" 21,232	8·80 " 9·20	0·40
" 22,040	10·40 " 9·59	0·81
'Force.'		
No. 21,226	12·50 and 12·90	0·40

Inference.—An error of about 0·5 per cent is unavoidable, and the method must not be held to any closer interpretation.

Hence determination of fat by any method involving determination of moisture must be altogether untrustworthy.

Fat.—(Petroleum Ether Extractive) by methods that involve estimation of moisture.

It is apparent that the following results have no value, except as illustrating the impossibility of accurately determining fat by indirect methods.

Five grammes was interstratified with fibrous asbestos in Macfarlane tubes, and extracted, in Soxhlet tubes, for eight hours. In most cases the solvent was applied without previous drying of the sample. The final drying was made at 105°–110° C. in air.

Sample.	Total loss to Petroleum Ether and Dry Air.			Moisture lost at 105°–110°.	Difference (Fat).	Fat (Ether Extract) obtained by direct Weighing.
	(a.)	(b.)	Mean.			
					p. c.	
'Malt Breakfast Food'—						
4,309	10·96	11·28	11·12	10·78	0·34	....
17,850	9·88	10·20	10·04	9·89	0·15	....
21,232	9·12	....	9·12	9·00	0·12	....
22,040	10·76	....	10·76	9·99	0·77	1·15
23,330	9·48	....	9·48	9·20	0·28	....
'Force'—						
4,308	11·52	....	11·52	11·40	0·12	....
17,427	10·72	....	10·72	10·65	0·07	....
17,851	12·36	....	12·36	11·25	1·11	1·26
'Malta Vita'—						
17,426	12·00	....	12·00	11·15	0·85	1·23
'Grape Nuts'—						
22,034	9·96	10·24	10·10	9·50	0·60	0·61
'Life Chips'—						
Special	11·24	....	11·24	9·90	1·34	1·69
'Ralston Breakfast Food'—						
20,230	13·20	13·20	13·20	12·50	0·70	1·42
21,684	15·12	....	15·12	13·64	1·48	1·65

The indirect method is untrustworthy inasmuch as (1) the difference between duplicate tests is often greater than the total amount of fat; (2) the preceding study of moisture determination shows an experimental error of about 0·5 per cent, which error would invalidate any results obtained for fat, in which the moisture per centage had to be deducted.

The following mode of operating has been found satisfactory:—Quantities of the material varying from 2·5 to 5 grammes are wrapped in fat-free filter paper and tied with ordinary sewing cotton. The cartridges so formed are dried in coal-gas, at 105°; and extracted in a Soxhlet tube with mixed pretroleum and ethyl ethers; or with petroleum ether only. The ether must be rectified, and found to leave no residue on evaporation. The extractive is evaporated to dryness in tared glass capsules, and weighed. If desired, the fat so recovered may be examined as to its refractive index, and its behaviour with reagents. The quantity obtained is, however usually too small to permit of detailed examination; and if the ordinary physical constants are to be determined, it is necessary to make a special extraction of a larger quantity of material.

The numbers given in the last column of the preceding table, were obtained by operating in this way.

It was noted that the fat recovered from the cereal foods examined did not gain weight on continued exposure to air at 100° C. for 15 hours.

ASH.

It is usually recommended to carry out the operation of 'ashing' in a muffle, maintained at a low red heat. This method is tedious in the case of cereals, which burn very slowly. It is advantageous to treat the partly burnt material with water, filter, and complete the incineration of the residue, (with the filter) finally adding to it the solids obtained by evaporating the filtrate to dryness.

Hebebrand (Zeit. für Untersuch, der Nahr. and Genussmettel, 1902, 719—through Analyst, 1902, 342) recommends a platinum dish having circular holes just below its edge. This is covered by a lid and chimney made of aluminium; and it is claimed that incineration is complete in about half the usual time with this apparatus.

The following determinations have been made in platinum dishes, over a Bunsen burner. The heat is kept low at first, but finally raised to distinct redness.

With samples of *Malt Breakfast Food*, the following percentages of ash were obtained:—0·58, 0·58, 0·54, 0·56, 0·52, 0·56, 0·56, 0·39, 0·47, 0·66, 0·60, 0·60; mean value, 0·56 per cent.

With samples of 'Force':—2·92, 2·76, 2·72, 2·60; mean value, 2·75 per cent.

With samples of Life Chips:—2·82, 2·38; mean value, 2·60 per cent.

With samples of Ralston Breakfast Food:—0·70, 0·86; mean value, 0·78 per cent.

Grape nuts, gave 1·64 per cent.

Rolled oats, gave 1·68 per cent.

CRUDE FIBRE.

This datum is necessarily of an indefinite character. In the following illustrative table, the work recorded was done after the method recommended by the association of American Agricultural Chemists. A variation in manipulation, by the introduction of a large centrifuge (see description of centrifuge at end of bulletin) somewhat facilitated the filtration. After the acid treatment, two to three volumes of alcohol are added, and the liquid whirled for twenty minutes or so. The addition of alcohol is necessary because the separated fibre is of nearly the same specific gravity as the menstruum. After alkali treatment, direct filtration has been found most satisfactory: the centrifuge being here of no advantage.

	Crude Fibre, p. c.—	
'Malt Breakfast Food'—		
No. 4309	0·94 : 0·90	Mean value=1·05
17850	1·08	
20225	1·24	
21232	0·96	
21685	1·00	
22040	1·44 : 1·08	
23330	0·80 : 1·06	
'Malta Vita'—		
No. 17[illegible]26	2·50 : 2·30	Mean value=3·15
21225	3·90	
'Grape Nuts'—		
No. 22034	2·6 : 1·46	Mean=2·03
'Life Chips'—		
Special	2·90	
'Ralston Breakfast Food'—		
No. 21684	1·64 : 1·72	Mean =1·68
'Force'—		
No. 17851 *(b)*	2·60	
'Rolled Oats'—		
No 23333 *(a)*	3·14	

NITROGEN.

The total nitrogen has been worked on 1 gramme of material, by the Gunning-Kjeldahl method.

The soluble nitrogen has been obtained by evaporating to dryness, in a Kjeldahl-digestion flask, 75 cc of a 10 per cent aqueous solution and treating the residue as above.

Evaporation is conveniently effected by aspirating a current of air through the flask, while this is on the water bath.

In a few cases this estimation has been made on a 5 per cent solution, and in every instance the dissolved nitrogen so obtained was notably higher. This would seem to point to the difficult solubility of the forms in which nitrogen is present in these substances.

—	Nitrogen—Per Cent.		
	Total.	Soluble.	
		Ten p.c. Soln.	Five p.c. Soln.
'Malt Breakfast Food'—			
No. 4309	2·12	0·31	....
17850	1·965	0·14	0·21
20225 (*a*)	1·96	0·15	0·25
20225 (*b*)	1·98	0·14	....
21232	1·82	0·17	0·28
21685	2·21	0·19	....
22040	1·92	0·155	0·241
23330	1·96	0·16	
Mean value	1·99	0·18	
'Force'—			
No. 4308	1·90	0·23	
17427	1·76	0·26	
17851 (*a*)	...	0·23	
17851 (*b*)	...	0·17	
21226	1·95	0·19	
Special	1·79	0.15	
Mean value	1·85	0·21	
'Malta Vita'—			
No. 17426	1·52	0·16	
21225	1·63	0·25	
Mean value	1·58	0·21	
'Grape Nuts'—			
No. 22034 (*a*)	1·90	0·30	
22034 (*b*)	1·93	0·30	
Mean value	1·92	0·30	
'Life Chips'—			
No. 21230	1·51	0·25	
Special	1·59	0·19	
Mean value	1·55	0·22	
'Ralston Breakfast Food'—			
No. 20230	2·29	0·26	
21684	1·70	0·25	
Mean value	2·00	0·26	
'Rolled Oats'—			
No. 23333 (*a*)	2·10	0·12	
23333 (*b*)	1·96	0·13	
Mean value	2·03	0·13	
Granulated oatmeal	2·08	0·18	
Peameal	4·41	1·19	
Cornmeal, ordinary	1·64	0.26	
" golden	1·43	0·07	

That differences in the nutritive value of the azotised components of cereals exist is a generally accepted fact. The proteids are doubtless of more importance as food material than the amidic substances, which are possibly intermediate products of their metabolism.

It is now equally certain that the proteids themselves vary in nutritive value. The following quotation is from the Monatsh. für Chemie, 1901, 991—through the Jour. Soc. Chem. Indust., 1902, p. 132:—

'A. Jolles has previously shown that there are essential differences in the proteids, and that, according to their constitution, a certain portion of the nitrogen is converted into urea on oxidation. Parallel experiments on man show that casein (which gives 73 per cent of its nitrogen as urea on oxidation) left 16·7 per cent of its nitrogen unabsorbed, while fibrin (which gives 45 per cent of its nitrogen as urea on oxidation) left 34·3 per cent of its nitrogen unabsorbed under similar conditions. Thus the physiologically nutritive value of the proteins in regard to nitrogen depends on the amount of the urea forming groups.'

It is quite probable that similar differences exist among the proteids of cereals; and possibly among the different proteids of the same cereal there may be found characteristic properties which shall justify efforts to cumulate one or another species of proteid for special food purposes.

I have placed the soluble nitrogen (amide nitrogen?) on record without any attempt to interpret it.

COLD WATER EXTRACTIVE.

This has been prepared by treating 30 grammes of the sample with 280 cc. distilled water. The resulting solution is nominally of 10 per cent strength—on the assumption that the density of the sample is 1·5. This assumption seems justified by the fact that the mean density of wheat flour is 1·56.

The solution is made by shaking the sample with the solvent for a period of 18—20 hours (over night) on an apparatus which I have called a 'rotator.' This consists of a wooden disc, to which 4 Erlenmeyer's of about 350 cc. can be attached radially. The wheel is 15 inches in diameter, and its surface is cut out in such a way that the Erlenmeyer flask fits into a depression, where it is securely held by rubber bands secured to small brass hooks screwed into the wheel. The whole is driven by a small water-motor at the rate of 30—40 revolutions per minute.

The separation of the insoluble matter is facilitated by the use of a large centrifugal machine (see description at end) making about 1,500 revolutions per minute. After 20 minutes in this apparatus the decanted liquid easily passes through ordinary filter paper, about 200 cc. being obtained, as a rule.

Unless the centrifuge is used, a very long sedimentation is needed, and it is difficult to get a liquid which can be filtered. Probably it would be best to work with 5 per cent solutions when a centrifuge is not available.

On the solution so obtained (solution A) the following estimations are made:—

1. Density.
2. Total solids in solution.
3. Reaction with iodine.
4. Reducing substances (Fehling solution).
5. Dissolved nitrogen.
6. Dextrine (matters precipitated by alcohol).
7. Preparation of solution B.

Work on solution A—(i.e., 10 per cent. solution).

1. *Density* has been determined by the sp. gravity-bottle at 15·5°C.

2. *Total solids*—20cc.—evaporated to constant weight at 100°C.—on asbestos fibre.

3. *Reaction with Iodine*—1 to 2 cc. is very much diluted with water, and a very dilute solution of iodine added. It is thus easy to avoid mistaking the brown colour due to erythro-dextrin. Where soluble starch as well as dextrin is present, the blue of the starch appears before the brown-red of dextrin.

Thus 'Force' gives *blue* and then *brown.*
'Grape Nuts' gives *brown.*
'Oatmeal' and some other foods give *no colour.*

4. *Reducing substances*—25cc (= 2 grammes) is made up to 50cc. with water, and heated to 100°C. This is poured into 50 cc. of Fehling's solution, also at 100°C., and the mixture kept at this temperature for ten minutes. The precipitated $Cu_2 0$ is then rapidly filtered off, and washed on an asbestos filter, using the pump. It is finally washed with strong alcohol, dried and weighed. The $Cu._2 0 \times 50 = Cu._2 0$ per cent as in the tables below.

5. *Dissolved nitrogen* has been already referred to. (See page 15.)

6. *Dextrin*—25 cc. (= 2 grammes) is concentrated to 10 cc., and any matters thrown out of solution by this operation are separated by filtration. To the filtrate (= 10 cc.) is added 100 cc. of alcohol (density = 0·810). The precipitate is collected on a tared filter, dried and weighed. Weight × 50 = dextrin per cent. The 'dextrin' so obtained cannot, of course, be regarded as pure. I have not had leisure to fully examine the character of the substances precipitated by alcohol; but shall investigate this matter at the first opportunity.

An examination of the tables will show that 2 to 3 per cent. of substances precipitated by alcohol is sometimes present when no iodine reaction for dextrin (erythrodextrin) occurs.

The following table gives a synopsis of the results of work, as indicated, on *Solution A*:—

Mean Results Obtained.

Breakfast Foods.	Density of 10 p.c. solution.	Dry solids p.c.	Reaction with Iodine.	Reducing substances. — As $Cu_2 0$ p.c.	'Dextrin.'
Malt Breakfast Food	1·0051	13·00	None to brown	7·29	3·24
Force	1·0129	29·60	Blue to brown	7·00	14·48
Malta Vita	1·0127	30·88	Blue to brown	16·20	9·26
Grape Nuts	1·0199	49·50	Brown	23·80	24·87
Life Chips	1·0087	19·30	....	9·85	12·16
Ralston Breakfast Food	1·0035	7·50	None	0·0	2·62
Rolled Oats	1·0025	6·19	None	0·0	3·58
Oatmeal	1·0020	....	None	0·0	
Peameal	1·0076	....	None	0·0	
Common Cornmeal	1·0035	....	None	0·0	
Golden Cornmeal	1·0019	....	None	0·0	

The aqueous solution (solution A) is, of course, strongly dextro-rotatory, owing to its content of dextrin, soluble starch and other optically active substances having right hand rotation. The solution is, however, always more or less opalescent, and cannot be read in the polarimeter without clarification. I have found the following mode of clarifying both simple and efficient:—

80 cc. solution A (= 8 grammes material), is treated with 16 cc. of a 7 per cent alum solution, followed by 4 cc. of ammonia solution of such a strength as to precipitate all the alumina and leave a slight excess of ammonia. (The ammonia solution is about

1·85 normal strength.) On gently warming, the hydrate of alumina separates in flocks, and the liquid is easily filtered.

Filtrate = *Solution B.*

Solution B, is read at 20° C. in a 2 dm. tube. The reading (S–V–sugar scale units) is multiplied by $\frac{100}{8} = 12 \cdot 5$, to convert it to a percentage on the sample; i.e., to a concentration of 100 per cent. The rotation is thus expressed in the analytical tables.

Since, however, the optical activity is due to substances dissolved from the cereal, and not to the whole weight of the cereal, it is preferable to state the rotation as a *specific angular rotation* on the soluble solids.

This calculation is made by the formula,

$$S = \frac{a}{1 \times \frac{c}{100}} = \frac{SV^{\circ} \times 0 \cdot 3468}{2 \times \frac{c \times p}{100}} = \frac{SV^{\circ} \times 0 \cdot 3468}{2p} = \frac{SV^{\circ} \times 0 \cdot 1734}{p}$$

or, $\text{Log } S = \text{Log } SV^{\circ} + \log \cdot 1734 - \log. P.$

where p = weight of soluble matter per 1 cc. of solution A, and 0·3468 is the A.O.A.C. factor for converting S V degrees into rotary degrees.

In the following table the rotatory power is stated in both ways, and the ratio of dextrin found to the total soluble matter is calculated.

OPTICAL (ROTATORY) VALUE OF SOLUBLE MATERIAL.

Name of Cereal.	S. V. degrees per 100 grammes.	Percentage soluble matter.	Specific rotation of soluble matter.	'Dextrin' precipitate by alcohol.	Ratio of Dextrin to soluble matter.	Iodine reaction of Solution A.
	°		°			
Malt Breakfast Food.	54·7	13·0	73·0	3·24	24·9	None to brown.
Force....	122·7	29·6	72·0	14·48	49·0	Blue to brown.
Malta Vita	194·0	30·88	109·0	9·26	30·0	Blue to brown.
Grape Nuts.	301·0	49·5	105·4	24·87	50·2	Brown.*
Life Chips	140·0	19·3	125·7	12·16	63·0	

The gyrodynat of *dextrin* is about 200°; that of *soluble starch* varies from 196° to 200°. Hence the reading given above cannot in any way serve to distinguish between these two substances. The ratio of the alcohol precipitate to the total soluble matter, and the reaction with iodine should, however, furnish a clue to the relative proportions of these substances. In order to secure further information on this point I prepared a third solution, as follows :—

Solution C.—50 cc. of the clarified solution B (= 4 grammes sample) is treated with 2 cc. strong HCl, and heated to 65° C. for 15 minutes. The cooled liquid is neutralized by ammonia, and alumina cream is added to make a volume of 75 cc. The filtrate (solution C) is read at 20° C., and the reading multiplied by $\frac{100}{6} = 16\frac{2}{3}$, to convert to S.V. degrees per 100 grammes.

Both *dextrin* and *soluble starch* are converted into dextrose by prolonged treatment with hydrochloric acid, the former more readily than the latter.* My object was

*An important paper on the hydrolysis of starch by acids, by Rolfe and Defren, was published in Journal Am. Ch. Soc., 1896 – p. 869. The authors find that the law (discovered by Brown and Morris in 1885) governing the conversion of starch by diastase, is essentially true of the conversion by acids. Their results show that the copper reducing power of the solution in progress of inversion, bears a constant relation to the optical value, under the most varying conditions of acidity, dilution, time of digestion, kind of acid used and pressure. Their conclusions are (1) In any homogeneous, acid converted starch product, irrespective of the conditions of hydrolysis, the specific rotatory power always represents the same chemical composition. (2) But three simple carbohydrates, possible in molecular aggregates, exist in the solution of a starch product hydrolyzed by acids (leaving out traces of reversion products.)

to secure conditions which would more or less closely discriminate between these substances. The gyrodynat of dextrose (+ 53°) is so much lower than that of either dextrin or soluble starch that a very decided alteration of rotatory power should result from this treatment. The numbers obtained are given in the analytical tables; but are so unsatisfactory that it is evident the inversion has proceeded quite irregularly and indefinitely. This is another point in which further work is required. In nearly every case the reading on inversion is lower than the original reading; but the extent of its change bears no simple relation to any known differences in the character of the solutions.

Starch.—It has not been possible to make a direct estimation of unchanged starch in all the samples. This estimation has, however, been made in several samples of the following brands, viz.: Malt Breakfast Food; Force, Grape Nuts and Life Chips.

The insoluble matter from 5 grammes of the sample was boiled for three hours with dilute hydrochloric acid (after Sachsses method), cooled, neutralized and made up to 500 cc. Aliquot portions of this solution were treated with Fehling solution, and the precipitated cuprous oxide calculated into starch (= dextrose × 0·92). The following results were obtained:—

STARCH.

Malt Breakfast Food	60·35 65·34	= 62·85 per cent.
Force	36·30 37.20	= 36·75 "
Grape Nuts	32·03 32·98	= 32·50 "
Life Chips	40·84 45·37	= 43·10 "

A. McGILL.

ANALYSIS OF BREAKFAST FOODS

Date of Collection.		Description of Sample by Food Inspector.	Name and Address of Vendor.	Name and Address of Manufacturer or Furnisher.	Serial Number.	Designation Number.	Moisture. Loss of weight at 110° in coal gas.	Fat. Petroleum ether extractive.	Ash.
1902.							p. c.	p. c.	p. c.
July	31	Breakfast Food...	Sanderson & Co., Charlottetown, P.E.I.	The Malted Cereal Co., Montreal.	1	4309	11·00 10·56	......	0·58
							10·78		
"	28	Cereal Breakfast Food.	G. M. & A. A. Barker, St. John, N.B.	" ..	2	17850	10·10 9·67	.....	0·58 0·54
							9·89		0·56
Aug.	6	Malt Breakfast Food.	S. L. Crop, Kentville, N.S.	" ..	3	20225a	10·20 10·60		0·56
							10·40		
"	6	" " ..	" " ..	" ..	4	20225b	9·74	1·10	
July	24	" " .	Hovey & Son, Cobourg, Ont.	" ..	5	21232	8·08 9·02	....	0·52 0·56
							9·00		0·54
"	30	" " ..	F. Filion, Vancouver, B.C.	" ..	6	21685	11·30 10·50	0·85	0·39 0·47
							10·90		0·43
"	29	" " ..	F. A. Hatfield, Calgary	" ..	7	21703	..	..	....
"	23	" " ..	C. W. Griffin, Wingham, Ont.	" ..	8	22040	9·59 10·40	1·19 1·10	0·66 0·60
							10·00	1·15	0·63
"	21	" " ..	J. B. Orr, Lennoxville, P.Q.	" ..	9	23330	9·20	....	0·60
						Means..	9·99	1·03	0·56

* Precipitate by alcohol, from water extract.

Proteids (calculated from mean total nitrogen × 6·25) = 12·44 per cent.
Mean calories per 1 gram = 4094·8.

FAST FOOD.

Crude Fiber.	Nitrogen. Total.	Nitrogen. Soluble.	Cold Water Extractive. Density of 10 p. c. solution.	Cold Water Extractive. Solids dry at 100° C.	Cold Water Extractive. Iodine reaction.	Dextrin.*	Substances reducing Fehling Solution. Cu$_2$O per 100 grammes. Before inversion.	Substances reducing Fehling Solution. Cu$_2$O per 100 grammes. After inversion.	Rotation in 2 dm. tube, per 100 grammes. Before inversion.	Rotation in 2 dm. tube, per 100 grammes. After inversion.	Remarks.
p. c.	p. c.	p. c.	p. c.	p. c.			p. c.	p. c.	°	°	
0·94 0·90 0·92	2·12	0·31	1·0043	12·00	......	1·88	5·52	6·45	+27·5	+30·0	Starch grammes mostly entire; but little cellular tissue visible; starch apparently wheat and oats (?) possibly barley.
1·08	1·97 1·96 1·96	0·14	1·0055	12·10	None..	2·24	7·00	7·36	+65·0	+75·0	
1·24	1·96	0·15	1·0047	......	......	3·44	.....	.....	.....	.....	
.....	1·98	0·14 0·14 0·14	1·0058	14·10	None..	3·44 3·24 3·34	7·90	8·85	+68·8 +67·5 +68·2	...... +60·0 +60·0	
0·96	1·82	0·17	1·0043	......	......	.....	.....	.....	.....	.....	
1·00	2·21 2·21 2·21	0·19	1·0056	13·30	Brown	4·00	.....	.....	+62·5	+70·0	
......	......	......	......	......	......	......	......	......	......	......	This sample did not come to hand.
1·44 1·08 1·26	1·92	0·16 0·15 0·155	1·0046 1·0056 1·0051	12·60 13·36 12·98	......	2·84	8·75	.....	+37·5	+40·0	
0·80 1·06 0·93	1·96	0·16	1·0056	13·50	Brown	4·95	.....	.....	+67·5	+46·6	
1·05	1·99	0·18	1·0051	13·00		3·24	7·29	7·55	+54·7	+53·6	Direct estimation of starch (unchanged) gave 62·85 per cent.

'FORCE'

Date of Collection.	Description of Sample by Food Inspector.	Name and Address of Vendor.	Name and Address of Manufacturer or Furnisher.	Serial Number.	Designation Number	Moisture. Loss of weight at 110° in coal gas.	Fat. Petroleum ether extractive.	Ash.
1902.						p. c.	p. c.	p. c.
July 31	Breakfast Food....	Beer & Goff, Charlottetown, P.E.I.	Force Food Co., Buffalo, N.Y.	10	4308	11·4	.....	2·92
Aug. 11	Force	D. W. McLean, Winnipeg.	" ..	11	17427	10·65	......	2·76
July 28	Cereal Breakfast Food.	Van Wart Bros., St. John, N.B.	" ..	12	17851*a*	11·25	.....	2·72
" 28	" ..	" ..	" ..	13	17851*b*	11·20 10·70 10·95	1·26	....
" 22	Force............	P. Bruneau, Montreal..	" ..	14	21226	12·5 12·9 12·7	......	2 60
" 22	"	" ..	" ..	15	Special .	14·54 14·59 14·56	1·26 1·30 1·28	
					Means..	11·92	1·27	2·75

MALTA

Date of Collection.	Description of Sample by Food Inspector.	Name and Address of Vendor.	Name and Address of Manufacturer or Furnisher.	Serial Number.	Designation Number	Moisture. Loss of weight at 110° in coal gas.	Fat. Petroleum ether extractive.	Ash.
Aug. 11	Malta Vita (concentrated malted food).	Hardy & Buchanan, Winnipeg, Man.	Battle Creek Pure Food Co.	16	17426	11·5 10·8 11·1	1·23	2·90
July 22	" ..	P. Bruneau, Montreal..	" ..	17	21225	12·0 10·2 11·1	1·28	3·10
					Means..	11·1	1·25	3·00

* Precipitate by alcohol from water extract.

FOOD.

Crude Fiber.	Nitrogen. Total.	Nitrogen. Soluble.	Cold Water Extractive. Density of 10 p. c. solution.	Cold Water Extractive. Solids dry at 100° C.	Cold Water Extractive. Iodine reaction.	Dextrin.*	Substances reducing Fehling Solution. Cu_2O per 100 grammes. Before inversion.	Substances reducing Fehling Solution. Cu_2O per 100 grammes. After inversion.	Rotation in 2 dm. tube, per 100 grammes. Before inversion.	Rotation in 2 dm. tube, per 100 grammes. After inversion.	Remarks.
p. c.	p. c.	p. c.	p. c.	p. c.			p. c.	p. c.	°	°	
.. ...	1·88 1·93	0·21 0·25	1·0118	26·3	Blue..	17·0	6·3	.....	+217·5	+100·0	Starch granules, mostly broken, and much fibrous tissue. Apparently wheat starch.
	1·90	0·23									
......	1·76	0·26	.....	36·6	" ..	......	6·7	.....	+112·5	+106·6	
..	......	0·23	1·0186	38·2	Blue-brown.	24·16	3·9	.....	+256·7	+173·3	
		0·23		40·1							
		0·23		39·0							
2·60	......	0·16 0·18	1·0084 1·0082	8·9 12·9	" .	8·36 8·32	7·75	5·35 4·80	+ 95·0 + 95·0	+ 23·3 + 40·0	
		0·17	1·0083	10·9		8·34		5·05	+ 95·8	+ 32·6	
.....	2·04 1·86	0·19	1·0129	34·7 35·1	" ..	10·72 10·64	10·55	9·85	+177·0	+130·0	Proteids (from mean total nitrogen × 6·25) = 11·56 p.c.
	1·95			34·9		10·68					
.....	1·79	0·15	...	......	......	12·8 11·6	.....	.....	.....	....	Calorific value = 3,845·1 calories per gram.
						12·2					
2·60	1·85	0·21	1·0129	29·6	... ..	14·48	7·00	7·45	+122·7	+108·5	Direct estimation of unchanged starch gave 36·75 p.c.

VITA.

2·50	1·53	0·15	1·0126	28·75	Blue-brown.	9·32	10·4	10·4	+137·5	....	Wheat starch, much broken, with much fibrous tissue.
2·30	1·51	0·17					18·3				
2·40	1·52	0·16					14·3				
3·90	1·63	0·25	1·0128	33·00	Brown	9·04 9·36	16·1 20·4	9·3 13·6	+250·0	+200·0	Proteids (from mean total nitrogen × 6·25) = 9·88 p.c.
						9·20	18·2	11·4			
3·15	1·58	0·21	1·0127	30·88	......	9·26	16·2	10·9	+194·0	+200·0	Calorific value = 3,840·3 calories per gram.

Date of Collection.	Description of Sample by Food Inspector.	Name and Address of Vendor.	Name and Address of Manufacturer or Furnisher.	Serial Number.	Designation Number.	Moisture. Loss of weight at 110° in coal gas.	Fat. Petroleum ether extraction.	Ash.
								GRAPE
1902.						p. c.	p. c.	p. c.
July 29	Grape Nuts....	J. T. Macdonald, Calgary.	Postum Cereal Co., Ltd., Battle Creek, Mich.	18	21704	....	....	....
" 21	Cereal Breakf ..	Edward Flaherty, Stratford.	" ..	19	22934a	9·5	0·55	1·64
" 21	" ..	" ..	" ..	20	22934b	9·4 9·3 9·35	0·61 0·62 0·615	....
					Means.	9·43	0·58	1·64
								LIFE
" 24	Life Chips........	Wallbridge & Clark, Belleville, Ont.	Health Food Co., London, Ont.	21	21230	....	....	2·82
" 24	" ..	" ..	" ..	22	Special.	9·9 9·9 9·9	1·69	2·38
					Means.	9·9	1·69	2·60
								RALSTON BREAK
Aug. 7	Ralston's Breakfast Food.	Shaw Bros., Windsor, N. S.	Robinson Danforth Milling Co., Purina Mills, St. Louis	23	20230	12·50 12·14 12·32	1·42	0·70
July 30	Breakfast Food...	F. Filion, Vancouver, B. C.	Purina Mills, St. Louis.	24	21684 *	13·64 13·80 13·72	1·65	0·86
						13·02	1·54	0·78

* Precipitate by alcohol from water extract.

NUTS.

Crude Fibre.	Nitrogen. Total.	Nitrogen. Soluble.	Cold water extractive. Density of 10 p. c. Solution.	Cold water extractive. Solids dry at 100° C.	Cold water extractive. Iodine reaction.	Dextrine *	Substances reducing Fehling Solution. Cu_2O per 100 grammes. Before inversion.	Substances reducing Fehling Solution. Cu_2O per 100 grammes. After inversion.	Rotation in 2dm. tube per 100 grammes. Before inversion.	Rotation in 2dm. tube per 100 grammes. After inversion.	Remarks.
p. c.	p. c.	p. c.	p. c.	p. c.			p. c.	p. c.	p. c.	p. c.	
......	. .	......	.....	......	......	......	......	......	......	....	This sample did not come to hand.
2·60	1·89 1·91	0·29 0·31	1·0202 1·0189	50·6	B row	24·92	26·4 25·4	18 1 17·4	+ 300·0 + 280·0	....	Calorific power (mean) = 3968 9 calories per gramme.
	1·90	0·30	1·0196				25·9	17·8	+ 290·0		Wheat starch; granules much broken; fibrous tissues.
1·46	1·93	0·29 0·30	1·0202 1·0201	48·1 48·7	"	24·76 24·88	21·5 21·7	16·0 15·5	+ 275·0 + 350·0	+ 240·0 + 300·0	Proteids (mean total nitrogen × 6·25 = 12·00 per cent.)
		0·30	1·0202	48·4		24·82	21·6	15·7	+ 312·0	+ 270·0	
2·03	1·92	0·30	1·0199	49·5		24·87	23·8	16·8	+ 301·0	+ 270·0	Direct estimation of unchanged starch gave 32·50 per cent.

CHIPS.

Crude Fibre.	Nitrogen. Total.	Nitrogen. Soluble.	Density of 10 p. c. Solution.	Solids dry at 100° C.	Iodine reaction.	Dextrine *	Before inversion.	After inversion.	Rotation Before inversion.	Rotation After inversion.	Remarks.
......	1·51	0·25	......	19·3	....	... ..	9·85	8·50	+ 140·0	+ 106·6	Calorific value (mean) = 3925·9 calories per gramme.
2·90	1·59	0·19	1·0091 1·0084	... ..	....	12·16	.....	.....	....	....	Broken starch granules. Much husk tissue.
			1·0087								Proteids (mean total nitrogen × 6·25) = 9·69 per cent.
2·90	1·55	0·22	1·0087	19·3	....	12·16	9·85	8·50	+ 140·0	+ 106·6	Direct estimation of unchanged starch gave 43·10 per cent.

FAST FOOD.

Crude Fibre.	Nitrogen. Total.	Nitrogen. Soluble.	Density of 10 p. c. Solution.	Solids dry at 100° C.	Iodine reaction.	Dextrine *	Before inversion.	After inversion.	Rotation Before inversion.	Rotation After inversion.	Remarks.
......	2·29	0·26	1·0038	7·0	....	3·32	......	......	....	....	Starch granules, mostly entire. Wheat and many small granules; rice.
1·64 1·72	1·67 1·74	0·25	1·0031 1·0033	8 0	None.	1·92	0·0	0·0	0	0	Proteids (mean total nitrogen × 6·25) = 12·50 per cent.
1·68	1·70		1·0032								
1·68	2·00	0·26	1·0035	7·5	....	2·62	0·0	0·0	0	0	Calorific value = 3911·7 calories per gramme.

ROLLED

Date of Collection.	Description of Sample.	Name and Address of Vendor.	Name and Address of Manufacturer or Furnisher.	Serial Number.	Designation Number.	Moisture. Loss of weight at 110° C. in coal gas.	Fat. Petroleum ether extractive.	Ash.
1902.						p. c.	p. c.	p. c.
July 22	Rolled oats.. ...	J. E. B. Campeau, Stanstead, Que.	The Ogilvy Milling Co., Montreal.	25	23333 (*a*)	10·45	......	1·68
" 22	"	" " ..	" " ..	26	23333 (*b*)	11·82 12·12	7·11 7·31	....
						11·97	7·21	
					Means..	11·21	7·21	1·68
" 22	Rolled oats...			27	Special.	10·84	6 91	1·14
" 22	"			28	"	10·40	1·33	2·62
" 22	"			29	"	13·12	5·21	1·42
" 22	"			30	"	14·90	2·01	0·58

TABULATION OF

Malt Breakfast Food	...	....	9·99	1·03	0·56
Force	...	.....	11·92	1·27	2·75
Malta Vita	...	....	11·10	1·25	3·00
Grape Nuts	...	...	9·43	0·58	1·64
Life Chips	...	...	9·90	1·69	2·60
Ralston Breakfast Food	...	....	13·02	1·54	0·78
Rolled Oats	...	....	11·21	7·21	1·68
Oatmeal	...	....	10·84	6·91	1·14
Peameal	..	....	10·40	1·33	2·62
Common Cornmeal	..	....	13·12	5·21	1·42
Golden Cornmeal	...	....	14·90	2·01	0·58

Calorific value per 1 gramme—
For Oatmeal .... 4270·6 calorics.
Peameal .... 4132·7 "
Cornmeal (Common) .... 4029·2 "
" (Golden) .... 3804 3 "

*Precipitate by alcohol from water extract.

OATS.

Crude Fiber.	Nitrogen. Total.	Nitrogen. Soluble.	Cold Water Extraction. Density of 10 p.c. solution.	Cold Water Extraction. Solids dry at 100° C.	Cold Water Extraction. Iodine reaction.	Dextrine.*	Substances reducing Fehling Solution Cu_2O per 100 grms. Before inversion.	Substances reducing Fehling Solution Cu_2O per 100 grms. After inversion.	Rotation in 2 dm. tube, per 100 grms. Before inversion.	Rotation in 2 dm. tube, per 100 grms. After inversion.	Remarks.
p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	p. c.	
3·14	2·10	0·11 0·13	1·0024 1·0023	6·0	None.	3·52 2·48	0	0	0°	0°	Oat starch and fibre.
		0·12	1·0024			3·00					
....	1·96	0·16 0·09	1·0027 1·0023	6·95 5·80	None.	3·44 4·88	0	0	0°	0°	*Proteids* (mean total nitrogen × 6·25) = 12·69 per cent calorific value = 4242·2 calories per grain.
		0·13	1·0025	6·38		4·16					
3·14	2·03	0·13	1·0025	6·19	... ...	3·58	0	0	0°	0°	
....	2·08	0·18	1·0020	......	None.	......	0	0	0°	0°	Granulated oatmeal.
....	4·41	1·19	1·0076	. .	"	.....	0	0	+2·5°	0°	Peameal.
....	1·64	0·26	1·0035	......	"	..	0	0	0°	0°	Common cornmeal.
..	1·43	0·07	1·0019	.. ..	"	......	0	0	....	0°	Golden cornmeal.

MEAN RESULTS.

1·05	1·99	0·18	1·0051	13·00	None to brown.	3·24	7·29	7·55	+54·7°	+53·6°	Malt Breakfast Food.
2·60	1·85	0·21	1·0129	29·60	Blue or brown.	14·48	7·00	7·45	122·7°	108·5°	Force.
3·15	1·58	0·21	1·0127	30·88	Blue or brown.	9·26	16·20	10·90	194·0°	200·0°	Malta Vita.
2·03	1·92	0·30	1·0199	49·50	Brown.	24·87	23·80	16·80	301·0°	270·0°	Grape Nuts.
2·90	1·55	0·22	1·0087	19·30	Blue.	12 16	9·85	8·50	140·0°	106·6°	Life Chips.
1·68	2·00	0·26	1·0035	7·50	None.	2·62	0·0	0·0	0°	0°	Ralston Breakfast Food.
3·14	2·03	0·13	1·0025	6·19	"	3·58	0·0	0·0	0°	0°	Rolled Oats.
4·28	2·08	0·18	1·0020	3·85	"	....	0·0	0·0	0°	0°	Oatmeal.
1·36	4·41	1·19	1·0076	17·75	"	....	0·0	0·0	2·5°	0°	Peameal.
3·50	1·64	0·26	1·0035	6·30	"	......	0·0	0·0	0·0°	0°	Common Cornmeal.
1·18	1·43	0·07	1·0019	2·90	"	.....	0·0	0·0	....	0°	Golden Cornmeal.

Proteids (total nitrogen × 6·25)—
For Oatmeal = 13·00 per cent.
Peameal = 27·56 per cent.
Cornmeal (Common) = 10·25 per cent.
" (Golden) = 8·94 per cent.

CENTRIFUGAL APPARATUS FOR QUANTITATIVE ANALYSIS.

A piece of apparatus is described by F. Steimtzer in the Zeit. für Analyt. Chem., 1902, 100 (Abst. in Jour. Soc. Chem. Indust., 1903, 562).

The apparatus illustrated on page 31, was designed by me, and worked out with the assistance of Mr. Thornton, machinist, of this city. It has been in continuous use in my laboratory for five years, and has given perfect satisfaction.

It is driven at a rate of 1,500—3,000 revolutions per minute by an electromotor of one and a-half H.P. driving a countershaft from a main shaft and by a half crossed belt (d^1).

It consists of a heavy iron base plate (a), Figs. 1, 2, 3, 23 inches diameter and 1¾ inches high. Three iron pillars, 15 inches high, support a three armed head-piece (b), and between these two is journaled in bearings (a^1) the steel shaft (c), with driving pulley (d). This shaft works on a ball bearing (e) at the lower end (Fig. 3) and on a steel point (f) at the upper end. It carries a yoke (g), shown in detail in Figs. 3 and 4. This yoke supports two steel rings pivoted on steel bearings, into which rings slip easily, the tube supports of copper (h, h^1) which are of two shapes according as tubes of the form k, l or m are used. In Fig. 3 the two different supports are shown in position. These tube supports are of equal weight, so as to be interchangeable. At the bottom of each tube support is slipped a piece of rubber, being an ordinary rubber cork when (h^1) is used and the half of a rubber ball (h^0) perforated in the centre when (h) is used. The glass tubes (l) and (k) are ordinary, thick walled, test tubes, and must be well annealed. The various operations of precipitation, extraction, washing, &c., are performed in these tubes, the latter operation being done by decantation, after shaking (an operation greatly facilitated by a specially constructed shaking machine. The precipitate is usually packed down so firmly in the bottom of the tube after 5—10 minutes centrifuging, that the wash water can be poured off to the last drop or two. The tube (m) is a specially constructed separating funnel (about 175 cc. capacity) of such a form as to fit the tube support. The most troublesome emulsions are easily separated by the centrifuge.

In Fig. 1 is shown a cover (n) made of ⅛ inch steel plate, capable of being pulled down over the machine when in use as a safety protection. This is counterpoised by a weight (shown at (p) in Fig. 2), suspended on a cord running over friction pulleys which are supported by the top frame. The cover is running on guide rods (q) in guides (r). The tubes (k) hold about 30 cc. and are naturally preferred when sufficiently large for the work in hand. Tubes (l) hold about 125 cc.

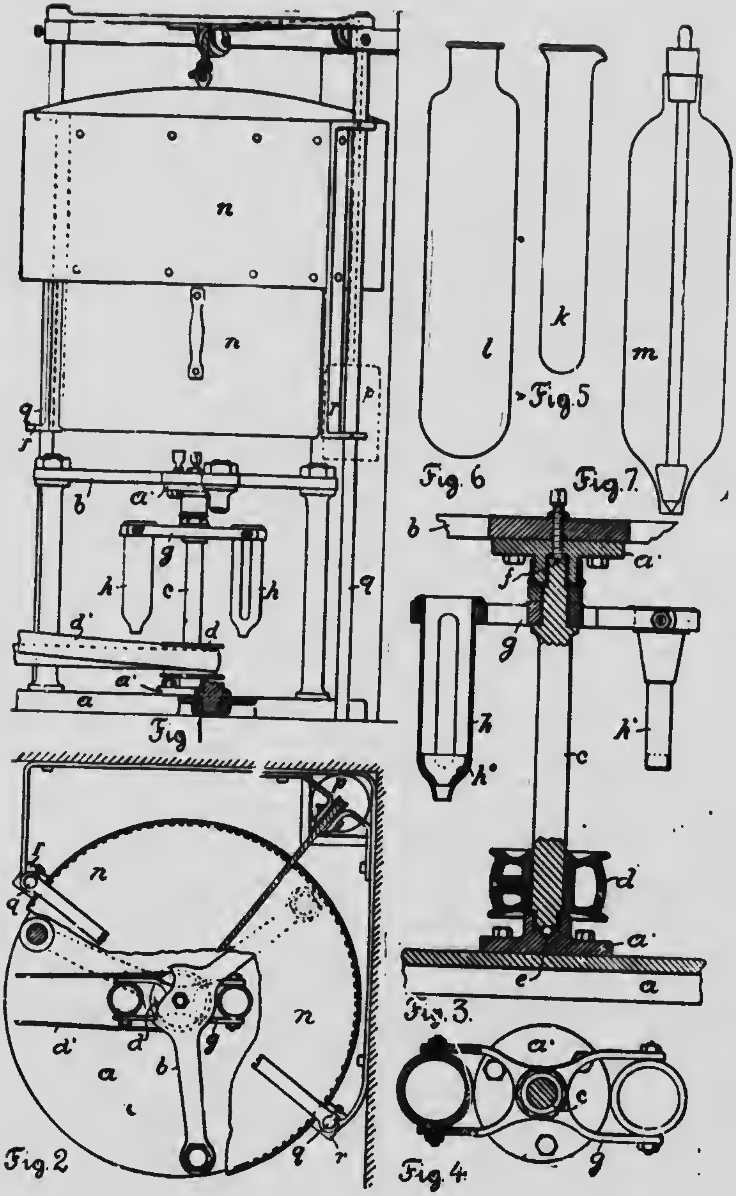
Fig 1
Fig. 2
Fig. 3.
Fig. 4
Fig. 5
Fig. 6
Fig. 7