Graduating Thesis

by

R. V. Clothier

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Topic

The Relative Food Value of Different Milling Products, as Indicated by Their Percentage of Nitrogen.

Outline

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  1 Gradual Reduction Process.
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The Relative Food Value of Different Milling Products as Indicated by Their Percentage of Nitrogen.

Since this thesis will deal largely with the relative food value of different brands of flour made from the same wheat, a short discussion of the process of manufacturing flour will be in order before taking up in detail the results obtained by chemical analysis.

Nearly all of the flour in the United States is now manufactured by what is known as the "gradual reduction process." In this process the wheat berry passes through several distinct stages of reduction before it is completely reduced to flour. The reduction is accomplished by means of rollers and each stage of the reduction is technically termed a "break."

Before the reduction process begins the wheat must be thoroughly cleansed from all foreign matter such as weed seeds, dirt, pieces of iron, &c. This is accomplished by means of various machines. Metallic bodies are removed

by passing the wheat in a stream over large magnets. Adhering dirt is removed by means of scouring and brush machines, while foreign seeds may be removed by means of screens. In some cases the wheat is also passed through a set of "ending stones" which remove the fuz from the end of the berry.

After the wheat has thus been cleaned it is passed through corrugated rollers set so as to just split the berry along the crease. This allows whatever dirt there may be still sticking in the crease to drop out and it is removed from the stock by bolting it through a wire screen bolting reel. The stock is then passed through from three to five similar sets of rollers, being bolted after each operation, or "break," and the flowy portion of the berry is at last almost completely removed from the bran.

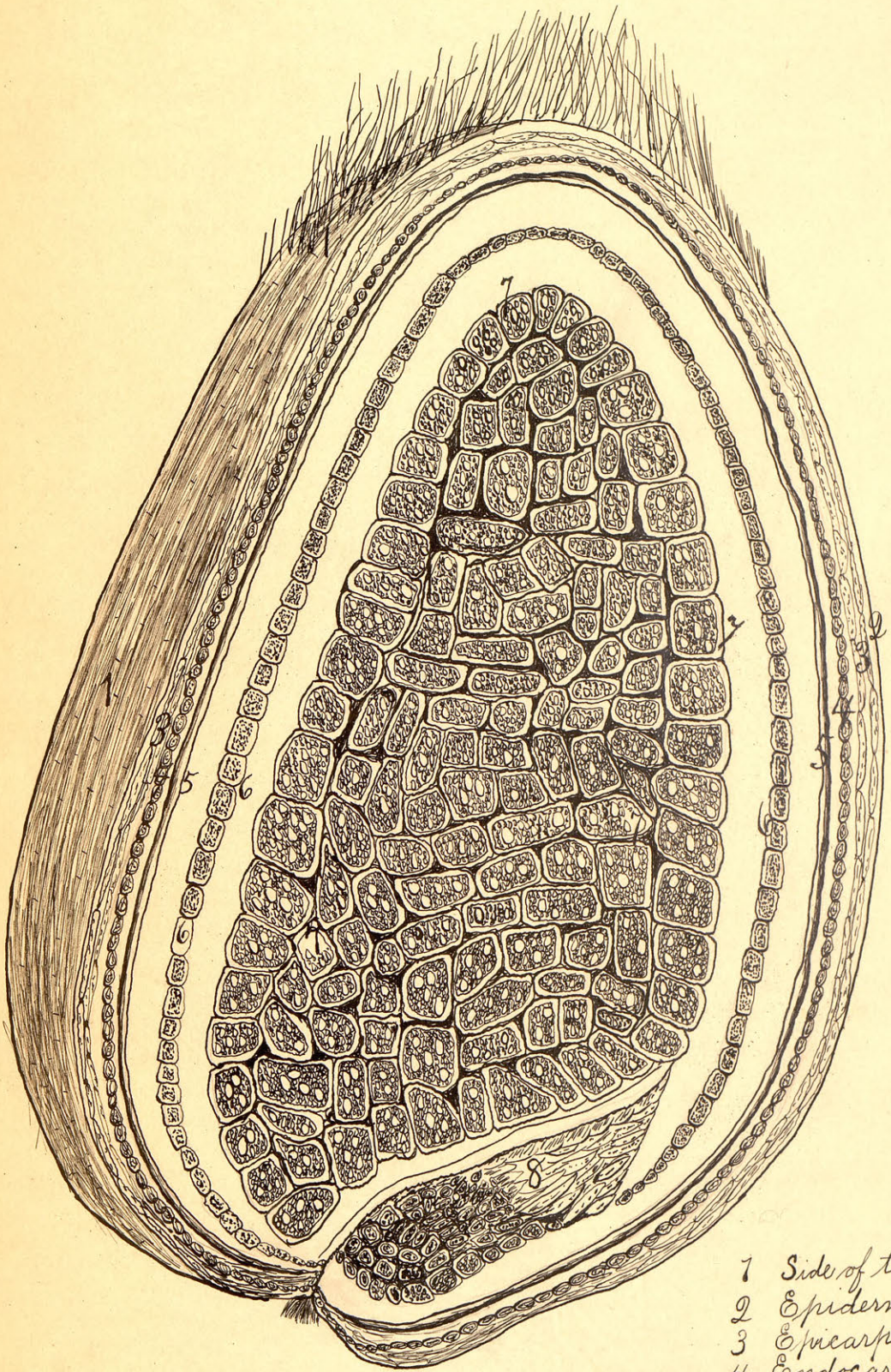
The products which go through the bolting reels after each break, termed, respectively, "first middlings", "second middlings, &c, are sent to middlings purifiers and are afterwards reground on smooth

rollers, and passed through bolting reels covered with silk cloth, the part which tails over being continually reground until all is reduced to flour.

The middlings purifiers are long sieves which have a vibratory motion and under which a current of air continually plays upwards, carrying away all dust and particles of bran, and leaving the middlings composed of fine, white, sharp particles.

The majority of bolting reels are cylindrical in form, are about thirty inches in diameter and have an average length of sixteen to eighteen feet. The crushed middlings enter the rotating cylinder at one end and are carried along towards the other end by a sort of screw arrangement, while all the time the flour is being sifted through the cloth by means of centrifugal force and is removed from the outside by a brush which plays against the cloth as the reel revolves.

The rollers are made of chilled iron in nearly all cases, though in some mills porcelain rollers are used for



1 Side of the Crease.
2 Epidermis.
3 Epicarp.
4 Endocarp.
5 Episperm.
6 Embryous Membrane.
7 Endosperm.
8 Embryo.

grinding the middlings. In all cases the rollers in each set are speeded at different rates, this giving them a sliding motion on each other which grinds the material passed between them.

Three distinct grades of flour are made in nearly all mills, and other grades may be made by blending these in different proportions. These three grades may be designated respectively, Low Grade, Straight Patent, and High Patent flour. They depend upon both the composition and texture of the wheat berry, and the method of reduction. The following drawing copied from a similar drawing by Mr. A. H. Churchill in a report of the flour milling processes of the United States, written by Mr. Knight Neftel for the Tenth Census Report of the United States will give an idea of the composition and structure of the wheat berry, and will assist in understanding the bearing this structure has upon the making of the different grades of flour.

The endosperm is the part of the berry which makes the flour. Its central portion is the softest part and has the greatest proportion of starchy material in it. It grows harder and richer in nitrogen towards the outer part. The flour made from the more starchy part is not rich enough in gluten to possess good rising qualities, while that made from the outer part, or more nitrogenous portion, is apt to be mixed with particles of bran which have become reduced by the combined action of the several different breaks through which they have passed. These particles of bran darken the color of the flour and thus injure its market value. The chief object to be aimed at by the miller, then, is to secure as much of the glutenous portion as possible without getting any particles of the bran mixed with the flour.

A small amount of flour is made in the first break. This being mixed with the dirt from the crease of the berry is sent to "low grade" flour, along with

that made from the last middlings which have become mixed with particles of bran. The germ, which is separated in the second break, is also sent to low grade flour.

High patent flour is made from patent stock which consists of the first three middlings. These, after being ground, are sent to a bolting reel having cloth of very fine texture. About sixty per cent. of the stock bolts through and forms the "high patent" grade of flour, while the tailings are reground and sent to lower grade flour.

Straight patent flour consists of all the flour made from the berry except that sent to the lowest grade.

The high patents have a decided preference in the markets, being often sold at prices ranging from twenty to thirty per cent. higher than the price of the best flour of other grades. The question arises, why is this true? Is the bread from high patent flour more nutritious, or more palatable, or are we paying merely for its beautiful white color?

To answer this question as regards nutritive value, and assign to each brand of flour its relative position in the scale of a few nutritive milling products is the object of this thesis.

Food is taken into the body to furnish heat and other energy, to repair broken down tissues, and to keep up the vital processes. Muscular tissue is broken down more rapidly perhaps than any other, and is composed of almost pure protein sixteen per cent. of which is nitrogen. Its repair, then, would require highly nitrogenous food. The vital processes also use up a large amount of nitrogen, and since nitrogenous foods are scarce and cost more than other kinds of food, the percentage of nitrogen contained in a given product would be one measure of its food value.

This is the measure used in this thesis. The amount of nitrogen may be determined in several different ways but in this case the Kjeldahl method was used. This method consists in

boiling the substance with sulphuric acid and mercuric oxide, then neutralizing with sodium or potassium hydroxide, and then distilling into a measured amount of acid of known strength, after which the acid is completely neutralized with ammonia solution of known strength. The explanation of this process is as follows: The boiling with sulphuric acid decomposes the proteids and changes their nitrogen into ammonia which unites with the acid to form ammonium sulphate. This is decomposed by boiling with fixed alkali and the ammonia distills off. The difference between the ammount of ammonia required to complete the neutralization of the acid in which the distillate is collected and the amount originally required is the amount of ammonia formed from the nitrogen in the substance. The amount of ~~of~~ nitrogen can be calculated from this result and the protein determined by multiplying the percentage of nitrogen by six and one fourth, since sixteen per cent. of protein is nitrogen.

Hydrochloric acid was used in which to collect the distillate, and its strength was determined by precipitating the chlorine with silver nitrate and weighing the precipitate, the amount of chlorine being calculated from this result. The strength of the ammonia solution was determined by measuring the amount required to neutralize a known amount of the hydrochloric acid, the amount of nitrogen in one cubic centimeter being calculated from this result. Solutions of acid or alkali of known stength are called standard solutions. A table is given below showing the results obtained in standardizing these solutions.

Twelve different milling products were analyzed. Of these, five brands of flour together with bran and shorts were obtained from C. Hoffman and Son, millers in Enterprise, Kansas. The Ralston flour is sold on the markets in Manhattan and is manufactured at Topeka. The four varieties of breakfast foods were obtained from grocers in Manhattan. Each different product will now

be taken up and discussed as to the results obtained by analysis.

Feed Stuffs.

Bran —: This product consists of the outer five coats of the berry, (see drawing) together with the embryous membrane and a small amount of the endosperm which was not separated as flour in the reduction process. A little more than thirteen pounds of bran are made from sixty pounds of wheat. Bran is the richest in nitrogen of all the products analyzed. It contains 22.25% of protein.

Shorts —: Shorts is composed of the dust from the middlings purifiers and the final tailings from all other grades of flour. Only a little over one pound is made from sixty pounds of wheat. It also, is comparatively rich in nitrogen, its percentage of protein being 21.81.

Flours.

Union Pacific —: This is a high patent flour made from patent stock. After the stock is regroud it is bolted through very fine bolting cloth and only about ten per cent. of it comes through. This

constitutes Union Pacific flour. It contains 16.25 percent. of protein.

Fanchon —: This is another high patent flour and contains about sixty per cent. of the patent stock. The tailings from Union Pacific flour are reground, then bolted through another reel, and the product which bolts through is Fanchon flour. It contains 14.91 per cent. of protein.

Supreme —; This brand contains thirty per cent. of the forty four and one half pounds of flour made from sixty pounds of wheat. It is a lower grade flour than the straight patent spoken of above. It is made out of the tailings of patent stock combined with the fourth and fifth middlings. It contains 18.22 per cent. of protein.

Old Gold —: This brand corresponds to the low grade flour mentioned above. It consists of the flour made in the first break and that made from the final tailings from all other brands. It contains 15.44 per cent. of protein.

Hoffman's Health Farina —; This is a brand of flour designed to meet the wants of members of the "Ralston

Health Club," and contains all the wheat but the bran. It contains 17.81 per cent. of protein.

Ralston Flour —: This is another brand of flour designed to meet the wants of "Ralstonites". It is called "pan cake" flour and is retailed in small packages at five cents per pound. It contains 12.69 per cent. of protein.

Breakfast Foods.

The four different breakfast foods analized ranked as follows:

Oatmeal, protein 16.31 per cent.
Farinose, protein 15.74 per cent.
Graham Flour, protein 14.47 per cent.
Rolled Wheat, protein 11.13 per cent.

Since Graham flour and rolled wheat are both "whole wheat" products they would be expected to show a much higher percentage of protein than the results obtained by the analysis. For want of time, no attempt was made to determine the cause of the deficiency.

From the foregoing results a few safe conclusions may be drawn. It is evident that, other conditions being equal,

the most nutritive portion of the wheat berry, namely, the bran and shorts, is fed to animals instead of being utilized as food by man. Of the flours, one patent brand, Union Pacific, shows a higher percentage of protein than the poorest brand of low grade flour, viz; Old Gold; while the other patent brand, Faneuil, shows a lower percentage of protein than this low grade brand. The best of the low grade flours, viz; Supreme shows the highest percentage of protein of all brands analyzed. The average of the two low grades compared with the average of the two high patents shows a difference of 1.25 per cent. protein, which corresponds to a difference of eight per cent. in nutritive value, in favor of the low grades. This per cent., when added to a difference of twenty to thirty per cent. in price, will make a difference of twenty eight to thirty eight per cent. in ~~food~~ value in favor of the low grades, other conditions being equal.

There are other conditions which should be taken into account in determining the true relative food value, such as relative digestibility, palatability, and

leavening qualities, but a discussion of them is beyond the scope of this thesis.

The "H. H. H." flour, although falling slightly below the best of the low grades, shows a comparatively high percentage of protein and hence is one of the most valuable of the products analyzed. On account of lack of information, we cannot give the relative composition of the Ralston flour, nor the process of its manufacture, but, from its comparatively low percentage of protein, it is evident that it does not meet the requirement of the members of the Ralston Club, namely, that of furnishing the highest possible amount of nitrogenous material in a given weight of food.

The products analyzed rank in nutritive value in the order named as follows: Bran, Shorts, Supreme Flour, "H. H. H." Flour, Oat Meal, Union Pacific Flour, Farinose, Old Gold Flour, Fanchon Flour, Graham Flour, Ralston Flour, Rolled Wheat.

The following comparative tables show the ranks of the different brands of flour and the breakfast foods, first in nutritive

value and then in price.

Flours.

Nutritive Value.	Price.
1. Supreme.	1 Ralston.
2 "A. A. A."	2 "A. A. A."
3 Union Pacific.	3 Union Pacific.
4 Old Gold.	4 Fanchon.
5 Fanchon.	5 Supreme.
6 Ralston.	6 Old Gold.

Breakfast Foods.

1 Oat Meal.	1 Farinose.
2 Farinose.	2 Rolled Wheat.
3 Graham Flour.	3 Oat Meal
4 Rolled Wheat.	4 Graham Flour.

Two analyses of each product were made and the average result taken in assigning the percentage of nitrogen. A full table of results is given below.

(See next page)

Table of Results.

Substance Analyzed.	First Analysis. Percent of Water	First Analysis. Percent of Nitrogen	First Analysis. Percent of Nitrogen Calculated to the Water-free Substance	Second Analysis. Percent of Water	Second Analysis. Percent of Nitrogen	Second Analysis. Percent of Nitrogen Calculated to the Water-free Substance	Averages. Percent of Water	Averages. percent of Nitrogen	Averages. percent of Protein
Bran	8.09	3.249	3.54	8.22	3.289	3.58	8.15	3.56	22.25
Shorts	10.86	3.10	3.48	10.90	3.12	3.50	10.88	3.49	21.81
Supreme Flour	11.79	2.61	2.96	12.11	2.528	2.87	11.95	2.92	18.22
*"H.H.H." ..	11.19	2.5657	2.89	11.17	2.495	2.81	11.18	2.85	17.81
Union Pacific ..	11.09	2.32	2.61	11.09	2.306	2.60	11.09	2.61	16.25
Old Gold ..	11.85	2.23	2.53	11.99	2.126	2.41	11.92	2.47	15.44
Fanchon ..	11.25	2.075	2.34	11.15	2.156	2.43	11.20	2.38	14.90
Ralston ..	10.84	1.78	2.00	10.89	1.84	2.06	10.865	2.03	12.69
Oat Meal	8.23	2.397	2.61	8.20	2.46	2.68	8.215	2.645	16.31
Farinose	6.85	2.36	2.54	6.84	2.33	2.50	6.845	2.52	15.74
Graham Flour	11.15	2.04	2.29	11.09	2.08	2.34	11.12	2.315	14.47
Rolled Wheat	9.87	1.59	1.76	9.88	1.62	1.80	9.875	1.78	11.12

* Hoffman's Health Marina.

Standardization of Hydrochloric Acid Solution.

HCl. used for each Precipitation	Weight of Precipitates. First.	Second.	Third.	Average.	Weight of Chlorine in 10cc. of Solution.	Weight of Ammonia Equivalent	Ammonia Solution required to neutralize 10cc. of HCl. Solution
10 C.C.	.7209 g.	.7210 g.	.7202 g.	.7207 g.	.178514 g.	.085783 g.	30.61 C.C.

Standardization of Ammonia Solution.

Amount of HCl. used for each Titration	Ammonia Solution Required To Neutralize 10 C.C. of HCl. First Titration.	Second Titration.	Third Titration.	Fourth Titration.	Average.	Weight of Ammonia Equivalent to 10cc. of HCl.	Weight of Ammonia in one cc. of Solution	Weight of Nitrogen in one cc. of Solution
10 C.C.	30.65 cc.	30.53 cc.	30.60 cc.	30.65 cc.	30.61 cc	.085783 g.	.0028024 g.	.002309 g.