

A GRAIN OF WHEAT .

BY

ELIZABETH J . AGNEW .

OUTLINE.

- I. Introduction.
- II. History.
- III. Structure.
- IV. Composition.
- V. Milling.
- VI. Nutritive Value of its Products.
- VII. Practical Use of Its Products.
- VIII. Summary.

There is, perhaps, no cereal so universally used as wheat; and not only is it now known almost every where, but even before history began to leave us records of the products of the past ages we find that the people of Europe had cultivated wheat, as samples have been recovered from the locustrine dwellings of Switzerland. Also, the Israelites in Egypt, ate leavened bread; the prophet Samuel, in the book which bears his name speaks of the "wheat harvest;" and the psalmist David, in his praise to God for His blessings upon the kingdom sings, "He maketh peace in thy borders and filleth thee with the finest of the wheat."

Ever since the far off days when our fore fathers first found the wild cereals, or began to cultivate them, men have known that food prepared from wheat would support life and strength better than any other single food except milk. The diet of the poor in India and China often consisted entirely of wheat or millet cakes or rice; and, altho in our own land the ease with which we can get other foods makes the use of wheat products of less importance, there are still many districts in Europe where the people eat very little else.

As we have before intimated, the history of wheat began in the remote ages. Asia was supposed to have introduced it into Egypt; Demeter into Greece, and Emporer Chin-Wong into China, about 3000 years before Christ. The first wheat raised in the "New World" was sown by the Spaniards on the island of Isabella, in January, 1494, and on March 30th, the ears were gathered. The foundation of the wheat harvest of Mexico is said to have been three or four grains carefully cultivated in 1530, and preserved by a slave of Cortez. In 1611, the first wheat appeared to have been sown in Virginia. In 1626, samples of wheat grown in the Dutch colony at New Netherlands were shown in Holland. It is probable that wheat was sown in the Plymouth colony prior to 1629, tho we find no record of it; and in that self-

same year wheat was ordered from England to be used as seed. In 1718, wheat was introduced into the valley of the Mississippi by the "Western Company." In 1799, it was among the cultivated crops of the Pimos Indians of the Gila River, New Mexico.

In structure the wheat grain is a small, oval seed, which can be easily threshed from the stock on which it grows. Its outer layers are known to the miller as the bran. Of these, the three outermost form what is called the skin of the grain and constitutes three per cent, by weight, of the entire seed. The three remaining layers of the bran form the envelope of the seed proper. The outer one is known as the "testa," and contains the greater part of the coloring matter of the bran. Inside of it, lies a thin layer of membrane. These two together form two per cent, by weight, of the entire grain. The innermost layer of the bran called the cereal or aleurone layer, is made up of rectangular cells, filled with a nitrogenous substance known as cerealin or aleurone. Its weight is about eight per cent of that of the entire grain, making the total weight of the bran about thirteen per cent. In milling, it is extremely difficult to separate these three inner layers of the bran. Within the cerealin layer lies the endospenn, as the portion of the grain adjacent to the embryo is called, which constitutes the larger part of the grain, and consists of irregular shaped cells containing starch granules. At the lower end of the grain, almost surrounded by the endospenn, lies the germ or embryo. A portion of the embryo is called the scutellum. This serves a special purpose in germination. When the grain has thoroly ripened and has been placed in favorable conditions, this embryo will develop into a new plant; and as it begins to grow, it will feed upon the starch and other substances in the endospenn.

Proximate analysis of the cereal grains shows that they contain as their principal constituents, fat, starch, cellulose, dextrine, one

or more sugars; soluble albuminous bodies, consisting of albumin, legumin, and cerealin; insoluble albuminous bodies consisting of myosin, gluten, mucedin and fibrin, which together constitute gluten; mineral matters, consisting principally of potassium phosphate and water.

The following, according to Bell, is the average composition of wheat:--

Constituents	Spring	Winter
Fat	1.56	1.48
Starch	65.86	63.71
Cellulose	2.93	3.03
Sugar	2.24	2.57
Albumen, etc., insol- uble in alcohol	7.19	10.70
Other nitrogenous matter soluble in alcohol	4.40	4.83
Mineral Matter	1.74	1.60
Moisture	14.08	12.08
Total	100.00	100.00

The quantity of fat in wheat is not a very important element in determining its value. Fat is, of course, an important food stuff, and as such is of service. The germ of wheat contains a very high percentage of fat, and when removed must necessarily lessen the percentage of this body.

Starch makes up the principal part of the grain as may be seen in the foregoing table. In these analyses the starch was probably determined by difference; that is, the percentage of the other constituents was subtracted from 100, and the remainder considered as

starch: the quantity of starch will therefore to the complement of the other bodies, rising when they fall and falling when they rise. Starch is of course of great importance as being the principal food-stuff of bread: in sound wheat the starch granules are whole, while in wheat which has sprouted, or heated unduly thru damp, the starch granules are pitted and often fissured. The result is that their contents become more or less changed into dextrine and sugar.

The cellulose is of considerable service to the plant; but to the miller it has no value, as being useless as an article of food, he endeavors to keep it out of the flour. As this is found principally in the bran the thinner skinned wheats will yield less cellulose. Judging by the cellulose alone, the less quantity present, the better is the wheat.

Dextrine exists in sound wheat in but small quantities; but when hydrolysis of the starch has set in, the percentage may considerably increase. Sugar is always present to a slight extent in wheat; and corresponds in properties to cane sugar. Since the sugar of flour affords the saccharin body necessary in fermentation, the presence of this compound in small quantity is not objectionable; but, as before pointed out, it should be principally cane sugar, the presence of much maltose bring evidence of unsoundness.

The amount of soluble albuminoids in wheat depends upon the damp years and wet climates in which the wheat is grown. The excess of moisture, and lack of warm, dry sunshine, leaves the grain damp and also leaves the albuminoids to be found in the soluble condition, instead of thorough ripening the grain, and thus causing them to assume the insoluble form.

The insoluble albuminoids, especially that known as gluten, are of great importance. Gluten is that constituent which imparts to wheaten flour its remarkable property of rising in a light spongy

loaf. As the gluten of wheat is that constituent which causes the flour to be a strong flour, wheats, to be of high quality, should contain a high percentage of gluten. This, however, is not of itself sufficient; the glutes of different wheats vary not only in quantity but in quality - some glutes are tough and elastic, others are soft and "rotten". These latter yield weak flours, and consequently bread which is not well risen; further the quantity of water they are capable of retaining is but small, and as a result, produce a comparatively low number of loaves from a sack of the flour.

The quantity of mineral matter present in a wheat flour consists mostly of potassium phosphate, a substance of considerable value from a nutritive point of view, and is found principally in the bran.

The water of wheat is found to be mostly associated with the starch of the grain; that body is extremely hygroscopic, and can only be obtained water-free by prolonged and careful drying. The quantity of water in wheat varies within the limits of fifteen and eight per cent. The question of importance is the influence of the water on the quality of the grain or flour. Wheat grown in a naturally damp climate, or during an unusually wet season, contains more water than that grown under the opposite conditions. Taken into consideration without reference to the other constituents of the grain, a large proportion of water is to be deprecated, for the simple reason that water is scarcely worth purchasing at the price given for wheat or flour. This, however, is not the only objection. A much more serious one is found on the fact that an excess of water shows that the wheat is unsound and that in all probability the other constituents will be of inferior character. In the first place, damp wheats and flours favour the development of those organisms which produce mustiness and acidity. In the presence of excess of moisture, too, the gluten of flour is rendered soluble in part and also loses its elasticity. Further, more or less

of the starch will be found to have been degraded into dextrine and maltose by diastasis.

When people first began to grind their grain, they did so simply by crushing it between two stones which happened to be handy; a little later they kept two flatones for the purpose, one of which they soon learned to keep stationary while the other was turned about on it. Now we have the original system of crushing between two stories, or rollers, but so elaborated as to be almost unrecognizable. In low milling, the grain is ground in one progress between two crushers placed as near together as possible. Graham flour and that known as "entire wheat flour" are prepared in this way. Of these only the former really contains the entire grain; it is made by simply washing and cleaning the grain and then grinding it between two stones or rollers, whose surfaces are so cut as to insure a complete crushing of the grain. Entire-wheat flour is made in much the same way, except that after being washed the grains are run thru a machine which removes the three outer layers, and then are ground. In this way, the supposed valuable cereal layer is included with out the almost useless cellulose of the outer bran. In high roller milling, the grain is washed and skinned as before, and then is run thru five or even more pairs of rollers, each successive pair being set a little nearer together than the last. After each grinding, or "break", as the miller calls it, the meal is sifted, and the leavings of each sifting, called "tailings", are themselves ground and sifted several times. In a mill where the grain goes thru a series of six straight breaks, there are as many as direct milling products, varying in quality from the purest white flour to pure ground bran. Careful millers always try to grind as near the cereal layer as possible, and to leave as much of the germ in the flour or is consistent with a good color. To make sure that each product is up to the standard set up for it in the mill,

samples of it are tested every hour and the milling is regulated accordingly. The so-called "straight grade" flours ordinarily seen on the market consist of the siftings of all the breaks plus the first product of the first tailings. "Patent and bakers'", or "household" flours are varieties of the straight-grade flours.

In considering the nutritive value of wheat, let us remember the principal kinds of nutrients which the body needs: (1) The nitrogenous substances, called protein compounds or proteids, typified by the white of egg and the lean of meat, and chiefly represented in wheat by the cerealin and gluten - these are the tissue building elements of our food, tho they also furnish energy; (2) the carbohydrates, principally starch and sugars, found mainly in the endospenn, and serving the body as fuel to produce energy for warmth and muscular work; (3) the fats, occuring principally in the germ of the grain, and being valuable to the body as fuel, and (4) mineral matters, seen in the ash, especially that of the bran, and providing material for bones, etc. We must also bear in mind that it is not only the chemical composition of a substance which determines its food value, but also the amount of nourishment which the digestive organs can extract from it, in other words, its digestibility.

The abundant cellulose in the bran and the coloring matter in the testa tend, if left in the flour, to give it a coarse, dark character very detrimental to the appearance of the bread. Accordingly, until recently, that flour was quite generally considered the best which had the least of the bran in it. Lately, however, much stress has been laid on the nutritive value of the mineral matters and the cerealin of the bran. Consequently, a great effort has been made to get a fine flour which shall include the entire wheat grain. Such flour cannot produce as white a loaf, and what is still more to the point, it is doubtful whether the cerealin is thoroly digested by the human stomach, moreover, the sharp, rough particles of the cellulose in the

bran are said to irritate the membranes of the alimentary canal and thus to hasten the passage of the food thru the intestines. This would tend to diminish its digestibility, altho it might be advantageous in counteracting a tendency to constipation, and hence be of value from a dietetic point of view. It would seem, then, that the value of bran in flour, unless it can be ground more finely than at present, is at least questionable. The germ, tho rich in fat and ash, is also of doubtful value in the flour, as it tends to darken the flour, and its fat occasionally grows rancid and spoils the taste.

The endospenn is by far the most important contributor to the flour. In its starch lies the chief nutritive ingredient of bread. The gluten is equally necessary; mixed with water it forms a tenacious, elastic body which expands under the pressure of the gas from the yeast until the dough is full of gas filled holes whose walls of tough gluten do not allow the gas to escape, and thus make the dough light and porous. The more gluten a flour holds, the more water it can be made to take up in dough, and the greater will be the yield of bread from a given amount of flour. Hence flours are classified as "strong" or "weak", according to the proportion of gluten which they contain and their consequent ability to yield bread. Gluten has also a high nutritive value as an easily digested proteid.

There are many uses to which wheat and its products are put, but the one toward which we will direct our attention is that of food for the human body; and as such we find it in various forms, i.e., break-^{fast} foods, flours, grahams, etc.

As a breakfast food, it is on the market in countless forms, such as, "Ralston's Breakfast Food", "Wheatena", "Wheatlet", "Pillsbury's Vitose", "Hecker's Farina", "Old Plymouth Breakfast Food", "Germea", "Foulds' Wheat Germ Meal", "Farinose", "Cream off Wheat", "Fruem Wheat Wafers", "Pettijohn's Breakfast Food", "The Battle Creek Granose", and

and many others. Judging from the protein content of the different wheat preparations just mentioned, it would appear that they are nearly all made from the soft starch wheats. This is an excellent way to utilize wheat relatively low in gluten, which will, in consequence, not make strong flour.

The flours and grahams are used in making the various kinds of breads, pastrys, cakes, puddings, sauces, etc. There is hardly any food, except milk, which is so universally used as bread; hence the importance of the proper understanding of the uses and abuses of the different constituents used in bread making. An ideal bread should fulfill certain diatetic conditions. First, it should retain as much as possible of the nutritive principles of the grain of which it is made. Second, it should be prepared so as to secure a complete assimilation of these nutritious principles; it should be light and porous, so that the digestive juices may penetrate it quickly and thoroly; it should be especially palatable, so that we will eat enough for nourishment; and it should be nearly or quite free from bran which causes too rapid muscular action to allow complete digestion.

Bread is made light by the use of yeast, which is, scientifically speaking, a minute fungus of the genus *Saccharomyces*. A single plant is around or oval one-celled, microscopic body, which reproduces in two ways - either by sending out buds which break off as new plants, or by forming spores which will grow into new plants under favorable conditions. It grows only in the presence of moisture, heat, and nutritive material. Yeast develops ^{best} but at a temperature of 77 - 95 degrees F. (25 - 35 degrees C.) The yeast plant is a ferment, which grows on a warm, sweet, moist, nitrogenous soil. It feeds upon nitrogenous matter by catholysis and breaks starch up into sugar, glucose and dextrose and again breaking these up into alcohol and carbondioxide. The entire process in chemical formula is: $C_6H_{10}O_5 + H_2O = C_6H_{12}O_6$

and $C_6 H_{12} O_6 = 2 C_2 H_5 O H + 2 C O_2$. Keeping the above facts in mind, it is easy to understand the leavening effect of yeast in dough. The yeast, "working" in the warm water and flour, feeds on sugar originally present or else produced from the starch by diastase, grows and spreads thruout the dough, at the same time giving off carbon dioxide gas, which forces its way between the tenacious particles of gluten and lightens the dough. The yeast plant grows better when it is supplied with a phosphate. It requires oxygen in growing and will decompose some of the sugar if it cannot get its necessary amount from the air. When it acts on sugar it breaks it up into glycerine and succinic acid. When lactic fermentation or ascetic fermentation takes place, the result is sour bread. This should be burned. Never try to sweeten it with soda water for if the soda is not all dissolved and neutralized it is liable to cause serious cases of ulcerations in the stomach. Bread is the most important of all articles of diet that can be properly classed under the starchy foods, and has been used since the dawn of civilization. The first bread was very tough and hard, and difficult to masticate. Modern bread is more healthful and more spongy. The small loaf that is crisp and spongy is said to be the best form in which starch can be presented to the digestive organs.

Besides the ordinary white bread just described there are innumerable fancy white breads, breads made from other flours than wheat, and unleavened breads on the market; but owing to our limited space we will not attempt to specialize here.

In conclusion, we will say, the lightness and sweetness of bread depends much on the way in which the wheat is grown and treated. As composed with most meats and vegetables, wheat grain has practically no waste and is very completely digested. It is too poor in protein to be fittingly used alone; but when used with due quantities of other foods

it is invaluable, and well deserves to be called "the staff of life". It is the foundation in all our "Standard Menus".