Innumerable difficulties are involved with such a plan but it is hoped it may be successful.

Within the last few months, two small commercial concerns have started developing this same branch of the industry. They have confined themselves as yet to preparing the more important reagents for which there is constant demand and to manufacturing the bacteriological stains needed so badly in physiological work. The prices charged by these firms are necessarily high, in fact so high that they are almost prohibitive to most of the university laboratories. These prices in the course of time will undoubtedly be lowered and the universities can then devote their energies exclusively to compounds required only for scientific research. It may be possible in the near future to have cooperation between these firms and the university laboratories, an arrangement which would be an advantage to all concerned.

Whether such small companies can live after the war and expand and so supply the demand for rare chemicals in this country is a question. It seems improbable that they will be able to compete with the foreign supplies unless a high tariff is levied. It is hoped however that the present work of these concerns may continue not only until the war stops but until such a time as a large chemical manufacturer as the National Aniline & Chemical Co. or the DuPont Co. will be in a position to undertake this branch of the industry in a thorough way and enter the business, not for profit but to be of real service to the country and to make the United States independent of foreign laboratories in this as well as other chemical lines. It is the present intention, at any rate, at the University of Illinois, to continue the work permanently, so that regardless of the great help that can be given outside, there may be a university where a graduate student in organic chemistry may be drilled in commercial methods before he goes permanently into technical work.

Roger Adams

University of Illinois

SHALL WE EAT WHOLE-WHEAT BREAD?[1]

The shortage of wheat and wheat flour, due to the excessive demands of the allied armies and neutral nations, has forced Federal and State Food Administrations to adopt certain policies in regard to the consumption of these very important foodstuffs. For example, steps have been taken to control the distribution of flour in a manner similar to that applied in the retail distribution of cane sugar. An educational campaign has been inaugurated with the view of educating the people to the consumption of larger quantities of the other cereals such as oatmeal, barley, rye and corn in substitution for wheat products. Another suggestion, which has met with some opposition, is that of milling a larger proportion of the wheat berry into flour, making what is usually termed a whole-wheat flour. The advocates of this idea argued that by milling a larger portion of the wheat kernel into the flour there would be less bran, shorts and middlings to be sold for stock feeds, wheat would go farther as a human food, and the amount saved would be available to assist in meeting the increased demand for wheat. The scientists and administrators supporting this view also contended that whole-wheat flour contained certain nutrients that standard patent flour did not contain and therefore was a better food and on account of the content of bran or "roughage" in the former it possessed a distinct advantage over the standard patent flour on account of its laxative action.

A counter campaign of education was immediately launched by certain of the milling interests represented by Professor Harry Snyder, formerly of the University of Minnesota. Professor Snyder has maintained throughout, both in public speech and in published articles, that "white bread is the best war bread" on account of the fact that it is more nutritious than the breads made from 82 per cent. extraction flour or flour milled from the entire

[1] Address before the University of Minnesota Section of the American Chemical Society, November 23, 1917.

grain (graham flour). Professor Snyder has gone a step further and makes the assertion that whole-wheat flour is not only less nutritious but is actually harmful, causing diarrhea and digestive disturbances. In this connection the statement is also made that the dairy industry can not be deprived of mill by-products which make up a very important part of the ration of the dairy cow.

There is little wonder that the consumer is at a loss to know what course to follow in his endeavor to do all in his power to cooperate with the government in the conservation of wheat.

It is not the object of this article to show that standard patent flour should not be milled; neither is it necessary to advocate that all of the wheat kernel should be milled into flour. The writer does contend that the attack on the higher extraction flours is unmerited, especially in view of the present situation; that whole-wheat flour is more valuable as a food material than the milling interests would lead us to believe; that whole-wheat flour when eaten with a balanced meal does not normally cause digestive disturbances, and that these views are held by many of the foremost authorities of food and nutrition in this and other countries. It might also be added that more economical feeds are available or can be made available for the dairy and animal industries.

It is to be expected that the milling interests would take the stand described above, for the people have been educated to believe that light, fluffy, white bread was the best bread for human consumption, and the milling interests have become organized both in personnel and machinery to give the people what they want regardless of its advisability. In order that the mill by-products should not represent financial loss, another artificial condition has developed in the live-stock and dairy industry. That they might dispose of the offal of the grain remaining after the manufacture of the white flour, the milling interests have encouraged the farmer to feed mill by-products, such as bran, shorts and middlings, until he has ceased to think of producing concentrated feeding materials and has become a victim of the mill-feed habit. Mill feeds have advanced in price with the result that dairy products have also increased in cost. The farmer is taught that he must feed wheat bran to procure the best results and at the present time bran is selling on the market at the exhorbitant price of $42.00 a ton and higher. If the farmer would only realize that he could produce as much milk at less cost by growing more corn and ensilage feeds; by growing more of those very valuable protein-bearing plants, clover and alfalfa, he would never again resort to the expensive mill feeds. In addition to obtaining valuable food materials cheaper, he would be increasing the value of his land by growing these legume crops, for they build up the nitrogen content of the soil and thereby assist in establishing a more permanent system of agriculture. In addition to their high content of protein, the legumes are very valuable on account of the large quantities of other nutrients; carbohydrates are relatively high and what is of great value to the dairy cow especially is the relatively large amount of calcium in these plants. Milk always contains a large proportion of this element and when the animal does not get a sufficient quantity in the feed (this is true with mill products) she is forced to take it from her tissues, *i. e.*, her bones. This happens when she is receiving fairly large quantities of calcium in her ration.

Taking up the question of wheat as a human food, we must realize at the outset that "man can not live by bread alone." This has been proven by scientific experiment. Wheat does not contain the right quantities of nitrogenous substances; its mineral content is far from ideal and the Wisconsin Experiment Station has shown that animals fed on a diet restricted to the wheat plant (cereal and straw) did not develop in a normal manner.

Normally, 100 pounds of wheat yield about 73 pounds of standard patent flour. Compared with whole-wheat flour patent flour is somewhat lower in protein but slightly higher in carbohydrates. When whole-wheat or graham flours are burned in a calorimeter so

that the heat can be measured, Professor Snyder has found that the higher extraction flours are equal to or exceed the patent flours in heat value. In one of his publications[1] in 1897 Professor Snyder states "omitting details of the separate experiments it was found that there was practically no difference in the total digestibility of breads made from the three kinds of flour (patent, baker's and whole-wheat flours)." And in proof of his argument Professor Snyder submits the following data:

TABLE XXVII

Digestibility of Bread

	Bread from Patent Flour. Per Cent. Digested	Bread from Bakers' Flour. Per Cent. Digested	Bread from Whole Wheat Flour. Per Cent. Digested
Dry matter.....	94	93	93
Protein.....	86	84	87
Fat.....	87	87	86
Carbohydrates....	97	97	97

These figures would lead us to believe that his conclusions are correct and we might even go further and say that the digestibility of protein was in favor of the whole-wheat flour. The protein in the whole-wheat flour was 12.81 per cent. and in the patent flour 12.44 per cent. This was in 1897. In 1901 Professor Snyder published the results of another set of experiments using other wheats and other men in the digestion trials and concluded that "while there actually may be more protein in a given amount of graham or entire-wheat flour than in the same weight of patent flour from the same wheat, the body obtains less of the protein and energy from the coarse flour than it did from the fine, because, although the including bran and germ increases the percentage of protein, it decreases the digestibility." Granting that Professor Snyder is right in either of his conclusions, we can rest assured that the difference in digestibility of the two flours is not great.

Professor Snyder states that 106 pounds of whole-wheat flour are required to be equal in nutritive value to 100 pounds of patent flour and it is upon this peg that all of the miller's arguments are hung.

[1] Bulletin 54, Minnesota Experiment Station.

Let us assume that 100 pounds of wheat are milled, yielding 73 pounds of patent flour and 100 pounds of the same wheat are milled to 82 pounds of whole-wheat flour and another 100 pounds are milled to practically 100 pounds of graham flour. Using Professor Snyder's own digestion coefficients,[2] we find that the energy available in patent whole-wheat and (graham breads were 90.9, 89.8 and 85.1 respectively. If we should feed 100 pounds of the same wheat in the form of patent flour (73 per cent. extraction), whole-wheat (82 per-cent. extraction) and graham flour, we would find that out of 182.64 large calories of heat in 100 pounds of wheat, man would actually be able to utilize for growth and development 115.64 large calories in the patent flour, 127.91 large calories in the whole-wheat flour, and 153.19 calories in the graham flour, showing a loss of 25 per cent. of available energy when patent flour is used. When the protein is compared, we find that Professor Snyder's figures show that out of 100 pounds of wheat we actually receive into the blood for tissue building purposes the following amounts of protein: patent flour, 8.75 pounds, whole-wheat flour, 9.68 pounds, and in graham flour 11.76 pounds of protein, showing a loss in patent flour of 25 per cent. of available protein.

Calculation also shows that if we feed bran, shorts or middlings to farm animals and then eat the meat, we lose from 60 to 80 per cent. of the available nutrients, which would indicate that it is more economical to utilize the greatest amount of the wheat kernel as human food and manufacture animal tissue on cheaper feeds.

The argument will be advanced that whole wheat flour costs nearly as much as patent flour and therefore the former figures are not applicable to present conditions. The present conditions are merely artificial—as soon as the people demand more of the whole-grain flours (which are milled at a lower cost than patent flour) just that soon will the price of the whole-grain flours begin to drop.

It is entirely feasible to mill higher ex-

[2] Snyder, 1903, U. S. Dept. Agr. Office Exp. Sta. Bull. 126.

traction flours at a lower cost than the present one. Millers argue that whole-wheat and graham flours do not keep in storage as long as patent flours. At the present time, this is not a question demanding consideration, for the flours are utilized within a few weeks of the time they are milled.

I do not wish to be interpreted as advocating the milling of flour containing the entire wheat kernel, but I feel that at the present time the higher extraction flours could be used to advantage.

From the standpoint of mineral nutrition, the higher extraction flours are more valuable as they contain a greater proportion of the mineral matter than the patent flours. The vitamines or growth-promoting substances of the wheat kernel are stored largely in the germ and are lost in the bran when patent flours are made. From this standpoint the higher extraction flours are more valuable.

It is an accepted fact that a large proportion of people are troubled with constipation; the higher extraction flours are valuable to correct this. In this connection we are told that the Belgian people were ordered by Mr. Herbert Hoover to make bread containing more white flour because of the digestive troubles experienced by the people on the whole-grain bread diet. Mr. W. C. Edgar, editor of the *Northwestern Miller,* states in one of his editorials that he was responsible for this order, having observed the digestive troubles experienced by the people. Mr. Hoover acted upon Mr. Edgar's suggestion. Dr. A. E. Taylor, physiological chemist at the University of Pennsylvania, went over the same ground and concluded that the people were suffering from malnutrition due to a one-sided diet, largely bread. He believes the digestive troubles to be secondary, due to broken-down constitutions and inability of the people to ward off disease. The latter conclusion seems the most logical, for the experience of the American people has been in direct opposition to the former idea, especially when eating well-balanced diets containing whole-wheat breads. In fact, we find the papers and magazines carrying advertisements of the larger milling companies advising us to eat bran in lieu of a ten-mile walk and become healthy. If we can eat wheat in the form of bran muffins and white bread, why not eat whole-wheat breads occasionally and save the miller the trouble and expense of separating them for us?

Regarding the nutritive value of the whole grain compared to the patent flours, practically all of our authorities in nutrition are agreed that the higher extraction flours are best. A government chemist of prominence wrote to 45 nutrition experts in the United States asking several questions, among which were the following:

1. "From your experience, is white bread a contributory cause of constipation?" The percentage of experts answering in the affirmative were 48.5, answering "no" 32.5 per cent., and the remainder were in doubt.

2. "Can whole-wheat or graham bread be considered helpful in constipation?" Here the affirmative answers represented 86.5 per cent. of the total number.

3. "Can long continued use of the whole-wheat or graham bread produce injurious results?" Seventy-five per cent. answered "no" to this question, while 5.8 per cent. of the writers were of the opinion that harmful effects could be expected. The others were in doubt.

4. "From the single standpoint of nutrition, which is preferable for general consumption by the people of the United States, white, whole-wheat or graham bread?" 65 per cent. expressed themselves in favor of whole wheat or graham, 10.8 per cent. being in favor of white bread and 16.2 per cent. had no preference.

5. "From the single standpoint of the laxative effect, which is preferable for general consumption by the people of the United States, white, whole-wheat or graham bread?" Here 86.5 per cent. of the authorities were in favor of the higher extraction flours.

6. "Considered both from the standpoint of nutrition and the standpoint of laxative effect, which is preferable for general consumption by the people of the United States, white, whole-wheat or graham bread?" Here

again the higher extraction flours received the approbation of 78.5 per cent.

7. "From your experience, which is the best flour, white, whole-wheat or graham?" Only 8 per cent. were in favor of the white flour, while 65 per cent. expressed a preference for the other flours.

Dr. Louis Lapicque, a nutrition chemist for the French government, stated recently[3] that his experiments led him to conclude that 85 per cent. extraction is necessary in France and that "for every five parts which are added when the yield is increased from 80 to 85, four of these are available."

When the layman is debating as to the best policy to formulate in stocking the family larder, he should keep in mind that the higher extraction flours are (1) not normally harmful, (2) are digested almost as completely as the lower extraction flours, (3) contain more valuable nutrients in the form of "vitamines" or growth-promoting substances, and mineral salts, (4) can be manufactured more cheaply when the public demands more of the whole wheat flour, (5) that the laxative action is beneficial, (6) and what is more important at the present time, more grain will be released for the allied armies, and (7) that these conclusions are supported by the majority of nutrition authorities.

If it is true that food will win the war, it is certainly a patriotic duty to save and conserve our wheat. One method is to include as a part of our daily diet food products made from higher extraction flours.

R. A. Dutcher
University of Minnesota

SCIENTIFIC EVENTS

THE OUTLOOK IN FRENCH AGRICULTURE

The *Revue Scientifique* for September 22 contains a report on the position and prospects of French agriculture presented by M. Louis Mangin, of the Académie des Sciences, to the National Council of the Ligue Française on behalf of the Committee on Economic Organization of that body. According to an abstract in *Nature* wheat production has fallen to barely 70 per cent. of the pre-war crop, potatoes to 80 per cent., wine to 65 per cent. and sugar-beet to little more than 30 per cent. The situation as regards live stock shows the same disquieting features. Practically 20 per cent. of the pre-war head of cattle fell into the hands of the enemy, and ill-devised measures taken to secure the meat supply in the early days of the war further seriously accentuated the shrinkage. Although the cattle position from the point of view of numbers has since been substantially improved, the proportion of young stock is so great that substantial relief of the meat stringency can not be expected from home resources for a considerable time. The decline in numbers of sheep which had set in long before the war has been greatly accentuated. Pigs also show a decline of 38 per cent. since the end of 1913. No reference is made to the position as regards milk production. A survey of the forest area completes the tale of depleted resources, something like one eighth of this area having been already denuded, with but little provision for its replacement.

Many suggestions are put forward for the relief of the present situation and for the future restoration and strengthening of French agriculture. The claims of rice as a diluent of wheaten flour are strongly urged in view of the large supplies available in the Asiatic colonies. To overcome the difficulties of shortage of manual labor on the land, the organization of supplies of African and yellow labor is suggested, whilst further relief could be obtained by a more active policy with reference to the production and use of motor tractors and farm machinery in general. The example of England in placing this manufacture under the same control as that of munitions of war is warmly commended. Consolidation of estates is urgently necessary and should be accompanied by a revision of the register of lands. The price of corn should be left sufficiently free to rise to encourage production, whilst at the same time the rise in the price of bread should be restricted by all appropriate means. It is suggested that these two ap-

[3] *Comptes Rendus de l'Acadamie de Sciences*, Vol. 165, p. 143.