Baking Quality of Flours of Five Hard Red Spring Wheats[1]

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IN wheat breeding investigations yield is a big factor, but the quality of bread that can be made from the flour milled from the wheat is so important that numerous tests of bread-making value must be made before any new variety can be considered for release by the Experiment Station. In particular the protein content of a new wheat, as well as the ability of the protein to produce good loaves of bread, must be satisfactory.

Will flour from one wheat variety produce better loaves than flour from some other variety when both contain the same quantity of protein? Will differences found between the flours at one protein level be encountered at second level? What will be the effect of differences in the baking formula on the relative ranking of the flours? These are important questions that have a direct interest to the farmer as well as to the baker and any testing program should be designed to yield information to assist in answering them.

To obtain a large range of protein levels it is necessary to have available a number of flours representing the wheat varieties subject to investigation and covering the desired protein range at suitable intervals. It is often impracticable to secure a series of this nature under natural field conditions because the range in protein content is largely controlled by environmental circumstances during seasonal growth. Another weakness in obtaining a substantial range in natural protein content is the possibility that samples of very unusual protein content may have inferior protein quality and thus introduce factors not encountered in sound wheat commonly used for milling purposes. These may seriously vitiate the results and lead to false deductions.

One escape from this situation is the use of flours adjusted by artificial means to the desired protein levels. A disadvantage of this method is that the resultant flours are not strictly "natural" in the sense that ingredients not present in the original flour have been added. However, if comparative treatments are employed and care is taken to insure that as far as possible the substances added are not altered from the natural state, one might presume that valuable trends would be revealed by the data obtained. The present paper presents results from a study of this nature conducted with five flours representing different hard red spring wheat varieties.

Wheat Varieties Tested

Flours representing hard red spring wheats of current interest to the wheat producers of the state were selected for investigation. These flours were each composited from experimentally milled samples of wheats grown at seven locations in 1943. The original wheats were sound and free from damage and had been grown under comparable conditions in the variety testing plots at each location. In wheat variety testing it is necessary that all the wheats be grown in the same experimental field and subjected to the same conditions of soil and climate. The wheats

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therefore are sown in replicated plots at each testing station, which is normal variety testing procedure. The replications tend to eliminate variations in wheat characteristics due to soil differences within the plot. The wheats were milled in an Allis-Chalmers experimental mill in a laboratory maintained at about 70° F. and 65 per cent relative humidity, to long patent flours of approximately 70% extraction.

The varieties employed were Thatcher, Rival, Pilot, Vesta and Mida. Thatcher is a stem rust resistant wheat which was released by the Minnesota Agricultural Experiment Station in 1934 and which has been widely grown in the hard red spring wheat region. Rival was released by the North Dakota Agricultural Experiment Station in 1939. This wheat possesses both stem and leaf rust resistance and has been extensively grown for the last two years in North Dakota. It resembles Thatcher in baking quality but tends to be somewhat weaker. It has a disadvantage from the farmer's viewpoint in its tendency to shatter in the field. Pilot is a variety released in the hard red spring wheat area in 1939 by the Bureau of Plant Industry in cooperation with the Experiment Station. This variety has not been as largely grown as the other two varieties mentioned, but has a substantial acreage in the State. It is rust resistant and has acceptable milling and baking qualities. It is probably not quite as strong as Rival. Vesta was developed by the North Dakota Experiment Station and released in 1942. It has been chiefly recommended for growth in the western portion of North Dakota.. Vesta has an extremely high flour yield but requires a long mixing period which is not entirely in its favor from the baker's viewpoint. Mida is a satisfactory wheat released by the North Dakota Station in 1944 and should find ready acceptance from the farmer. It is resistant to both stem and leaf rust and stinking smut, does not shatter as easily as Rival and stands erect in the field. It has a relatively high yield per acre and high test weight. Mida produces flour of low ash content which yields bread of excellent crumb color. This variety is of medium strength as compared with other hard red spring wheats grown in North Dakota.

Experimental Methods

The starch required for reducing the gluten content of the flours was prepared from an experimentally milled hard red spring wheat flour. Since the moisture and protein content of the starch were determined the quantity needed for any protein level blend could be readily calculated.

The glutens, each separated from the flour with which it was to be later blended in appropriate quantities, were mixed to a smooth dough with the flours, thus increasing the protein content of the blend to the different levels desired. No difficulty was experienced in incorporating the gluten in the dough, and no trace of gluten fragments was noticeable after mixing.

A micro method was used in baking the doughs. This method entailed mixing approximately 50 grams of the flour and dry starch, or flour and crude gluten, with the baking ingredients to a dough of normal consistency. Two portions of the dough weighing 37.5 grams each were then scaled for fermentation and baking, and thus two loaves were obtained from each dough mixed. The micro procedure was well adapted to this type of work because of the small quantity of materials needed as compared with other baking methods which require larger quantities of flour. Two baking formulas were employed. One of these will be called the malt-phosphate-bromate formula and consisted of 0.3 percent diastatic malt, 0.1 per cent ammonium phosphate, 0.001 percent $KBrO_3$, 3 percent yeast and 7 percent sugar. The other formula, designated as the "rich" formula contained 0.2 percent malted wheat flour, 4 percent dry milk solids, 3 percent shortening, 0.001 percent $KBrO_3$, 2 percent yeast and 5 percent sugar. Three-hour fermentations were used for both formulas. The crumb color and grain texture score was determined the morning after baking, the loaves having been kept overnight in a humidified cabinet at room temperature. A fluorescent lamp was used as light source and the same operator did

all judging. A loaf from a standard commercially milled flour was used each day as a color and grain-texture standard.

Discussion of Results

Absorption increased in a fairly regular manner with protein content for all flours, and this observation corresponds with the accepted belief of commercial bakers that high protein flours are "thirsty" and commonly require more water to yield doughs of normay consistency. There was little consistent difference apparent in absorption between the two formulas, although one would expect the "rich" formula to require more water, since it contained 4 percent dry milk solids and the doughs had normal consistency. It is likely that the presence of shortening tended to offset the effect of the milk.

A diagram was prepared to show the relations between protein level and loaf volume for each of the five flours. This is presented in Figure 1. It is evident that there are certain differences in the results secured by the two baking formulas at the lower protein levels. The rich formula gave larger loaves but this situation was reversed at high protein contents with the exception of Pilot. The protein level (above 15 per cent) at which the four curves intersect are approximately the same and this would indicate that these four flours tend to respond in very much the same way to the two formulas. Pilot, however, differs from the other wheats studied in this respect, since there is no intersection or crossing over in the two formula curves. The explanation of this difference is somewhat difficult; the genetic background of Pilot is different from that of three of the other wheats studied but on the other hand Thatcher is different in ancestry from Rival, Vesta and Mida.

Vesta gave the smallest response to protein content while Mida gave the best. This would apparently indicate that Mida has somewhat better response to increase in protein content than the four other varieties in 1943. For all the five wheats, loaf volume increased fairly consistently with protein content.

The crumb color score was compared with flour protein content but as no relevant variations were brought to light the data will not be presented. It was found that crumb color decreased slightly with increasing protein in flours diluted with starch chiefly because of a

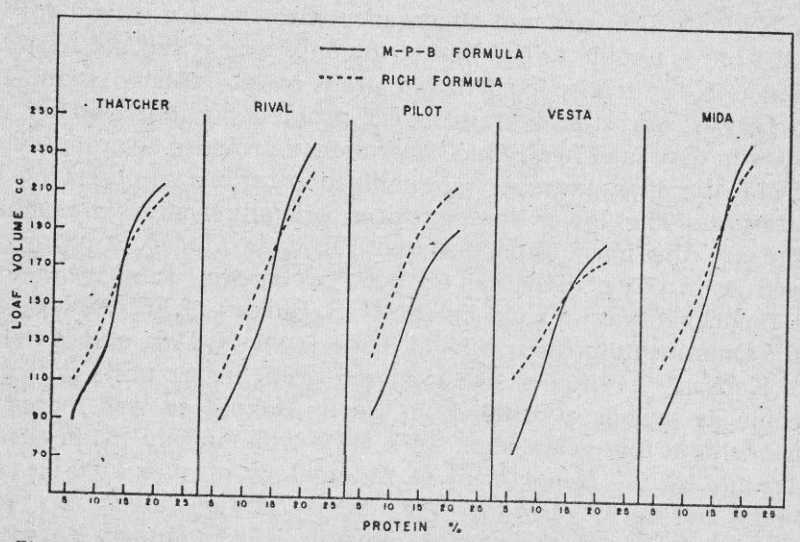

Fig. 1.—Relations between protein content and loaf volume by two baking methods for the five hard red spring wheat flours.

light sheen contributed by the starch when present in a relatively large quantity. In undiluted spring wheat flours of corresponding protein content the color score would be definitely lower. The color score decreased rather markedly above approximately 15 percent protein content owing to the increased quantity of gluten incorporated in the dough. The gluten, especially in the instance of Thatcher, carried a yellow tinge into the loaf. A comparison of the crumb color of the original flours showed Mida to have the best color, with Vesta second. The crumb color was generally improved by the rich formula, as one would expect.

Grain and texture scores tended to increase as the quantity of starch was reduced and the protein content increased. However, the larger additions of gluten decreased the score, in a somewhat comparable manner to the color values. The "rich" formula tended to give loaves with improved grain and texture.

Summary

The results from this investigation show that satisfactory loaves can be produced from blends of flour with gluten separated from the same flour. The absorption of the doughs varied directly with the protein content and agrees with the observation of commercial bakers that flours of high protein content normally need more water to form a dough. The loaf volumes secured from the blends also increased with protein content in the instance of each variety studied. The baking method used caused marked differences in the results secured as would be expected from **a priori** considerations. The different wheat flours did not react in precisely the same manner in respect to the two baking formulas and differences are also apparent between the varieties in respect to the results secured with each formula. Apparently some differences in protein quality exist among these wheats, but not to as great an extent as might have been suspected.

The serious grain pest of this area is the granary weevil. It is almost identical in size and appearance with the rice weevil (of the South) but is unable to fly; hence, the only way it can get from bin to bin is to be transported in old grain sacks, infested grain, etc. The fact is, our stored grain insect problem as indicated by our studies to date is of negligible consequence provided farm operators and elevator men exercise reasonable precautions in observing bin sanitation. The lower temperatures prevailing in this northern range are the most important natural factor for controlling the stored grain pests. This has all been pretty well substantiated by the experiments conducted by the U. S. Bureau of Entomology and Plant Quarantine in their bins at Jamestown, N. Dak. and Hutchinson, Kansas. I rather doubt if stored grain insect pests will ever become as serious a problem in North Dakota as was feared by some folks a few years ago. In a state-wide survey made several years ago by the Department of Entomology of over 1100 elevator owners and farm operators only seven storage structures were found infested with the granary weevil. (J. A. Munro, Entomologist).