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Potential Benefits for Bakers from Improved Protein Contents in Hard Winter Wheats

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Hard red winter wheats have been grown in the Great Plains area of the U.S. for the past 100 years. When Turkey Red wheat was introduced, the newly broken prairie soil had a high level of nitrogen fertility. This was coupled with rather low yields and grain was produced with high protein levels. After a century of wheat production the initial soil fertility was depleted in the drier areas where nitrogen fertilizer was not used.

Wheat breeders have continued to develop wheats with increasingly high yield potential—especially in the past 25 years. During this time, although there was a wheat acreage decrease of 62 per cent, wheat production increased 56 per cent.

When wheats with high yield potential are grown without fertilizer and under adequate moisture there can be a depression in grain protein.

Use of Nitrogen Fertilizer

Increases in protein quantity can be achieved with applications of nitrogen fertilizer but there can be problems if extra growth results in lodging during periods of high rainfall. With low rainfall, plants may be harmed from too much nitrogen fertilizer.

The influence of environment on wheat is large. Protein contents of a variety may range from 8 to 18 per cent, depending on growing conditions.

This strong influence of environment on protein level discouraged serious breeding efforts to increase the protein content of wheat. However, the discovery of a genetic source of the high protein characteristic in 1954 in the soft winter variety Atlas 66 provided a reliable basis for a wheat breeding project in Nebraska to improve the grain protein potential in hard winter wheats. "High protein" does not imply a "fixed" level in the grain, but rather a higher level than conventional varieties grown under the same conditions.

Improved levels of wheat grain protein require a combination of plant type with improved straw strength along with the genetic capacity to produce higher levels of grain protein. Soil nitrogen level must also be adequate.

Wheat Breeding and Selection

Man and nature have been "selecting" plant and grain "quality" types for thousands of years. However, modern wheat breeding, based on a knowledge of genetics, started only about 1900. Tremendous progress has been made in a relatively short time in both basic and applied techniques.

In order to get new plants with desired combinations of genetic properties, one must have a wide range of genetic materials available. A plant with a specific trait, such as higher grain protein, is "crossed" to a good agronomic type. Hopefully, the breeder can recover, in the progeny, a plant with good agronomic properties in combination with higher protein.

New spring wheat varieties take five to seven years to produce (with propagation of two generations per year). Winter types may require 10 to 15 years because of difficulty in producing two generations a year. Because of this time factor, once a basis for selection has been established for a particular quality feature in a winter wheat, it may taken 10-15 years to introduce a new trait into an improved variety.

Breeding objectives must always be concerned with yield potential. Each production area has its many interrelated problems of insects and diseases. In addition to high and stable yield potential, the breeder must consider the end use of the grain by processor and consumer.

The Nebraska wheat breeding program had selected higher protein

wheats with normal yield potential by the early 1960's. However, baking quality of the new lines, based on loaf volume and dough mixing characteristics, was not equal to conventional varieties at equal protein levels. An additional 12 years has been spent in selecting for more conventional quality types in order to maintain quality for existing blending techniques and baking procedures.

However, stereotyped thinking is a danger, and the potential of these new wheat materials may need to be examined in relation to new criteria.

Considerations of Protein Content

Protein level is the first quality limiting factor in pan bread production. Usually a protein content of 11.5 per cent is adequate. Often, if the loaf volume potential is outstanding, the protein requirement could drop to 11.0 per cent.

If the consumer is to be supplied with a more nutritious loaf of bread from new high protein wheat varieties and/or lysine fortification—perhaps the traditional concept of quality should no longer apply. The most important objective should be to supply a nutritious, palatable product with adequate loaf volume.

During recent years both the processor and consumer have been reassessing the role that nutrition should play in their product.

The consumer and the baker are confronted with increasing food and processing costs, respectively. The possibility of providing more of the dietary protein through wheat products at a reasonable cost should not be overlooked. A high protein line is currently under increase for possible release in Nebraska.

Research on techniques to fortify bread with proteins and/or amino acids has been successful. Additives are available which will maintain conventional loaf volume while increasing protein nutrition from oilseed proteins.

Fortification with protein or lysine for lowest cost should start with as much wheat protein as is possible.

The complete wheat industry, including the consumer, will need to reorient its thinking. The grower will need to supply all the soil nutrients that are required. The wheat marketing price standards must realistically reflect the value of the product. The baker should keep the formulation as simple as possible and be paid a price which still gives the consumer a bargain over other protein sources.

Future Nutritional Potential

On a worldwide basis wheat supplies more protein and calories in man's diet than any other single food source. During the past 20 years there has been a continuing University of Nebraska and U.S.D.A. Agricultural Research Service effort to improve protein content of wheat.

In 1966 AID (Agency for International Development) provided financial support to help expand the work to include improvement of both protein quality and quantity.

Initial efforts consisted of screening the USDA World Wheat Collection to identify sources of higher protein and/or lysine. Lysine was determined because it is the first nutritional limiting amino acid in wheat protein.

Wheat breeders have crossed the most promising nutritional lines in various combinations. Additive effects have been noted for several protein and lysine sources. In addition, combinations of high protein and lysine have produced lines combining both factors.

Phase I: This would entail the use of higher protein wheats which have been developed and should be available in about five years. *Phase II:* This would have the additional advantage of higher protein coupled with increased lysine content and/or greater lysine availability.

The present discussion has dealt primarily with implications to hard bread wheats. There is even a wider range of implications to improved protein nutrition when the whole array of wheat (quality) types and their products are considered.

Other Quality Implications

During the past 10 years there has been almost a complete turnover in wheat varieties grown in the U.S. It is to the credit of private, state and federal quality laboratories that during this time the general bread baking potential has improved. Quality types generally have moved in a direction to provide more tolerance to processing factors.

New wheats have been necessary to provide yield stability to old and new production hazards. For example, wheat grown in the southwestern U.S. provides an opportunity for wheat rust spores to overwinter. This innoculum, moving north during the growing season, has produced disease conditions which eliminated non-resistant varieties. Continued stable production requires that all new varieties have some level of resistance to rust.

Mixing time requirements of wheat flour doughs have lengthened over the past 20 years. This resulted from the effort to improve tolerance to overmixing which is always associated with longer mixing times. At present there is a need to reduce power consumption in the U.S. It may be possible to identify new wheats producing adequate loaf quality over a wide range in mixing time. This approach would provide a useful "tolerance" for the baker for mixing requirements.

Perhaps there has been a greater interest in the protein properties of new wheats than in their starches. Starch types have been selected over a fairly narrow range based primarily on the baking test. Softer crumb types have been discarded which might have made a substantial contribution to added shelf life. This could be a significant factor under our current bread distribution system and concern for food additives.

Wheat breeders can respond to a well defined measurable quality need. However, quality has meaning only in a particular application.

When new baking research is conducted there is usually standardization to the existing quality types. Likewise, quality laboratories working with breeding programs tend to measure the suitability of a new line against rather conventional quality types.

As communications between the baking industry and plant breeding programs continue perhaps some well defined quality needs can be identified. If genetic variability for the factor exists it should be possible to modify future wheats to better meet the needs of the baking industry.

THE END