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Current status of hexaploid triticale quality

[redacted] SKOVMAND **

* *International Maize and Wheat Improvement Center (CIMMYT) Londres 40, Apartado Postal 6-641, 06600 Mexico, D.F. Mexico*
** *CIMMYT, P.K. 120 Yenimahalle, Ankara, Turkey*

INTRODUCTION

Evaluation by CIMMYT of the industrial quality of triticale began in 1972. This work was initiated with eleven triticale lines, which were selected during the 1971-72 winter cycle at the CIANO experiment station, near Ciudad Obregón in the northwest state of Sonora, Mexico. These lines possessed the best grain type available at that time; even so, the seed was badly shrivelled and test weights and flour yields were thus very low compared with bread wheats. The eleven samples had test weights ranging from 63 to 69.9 kg/hl, with an average of 67.8 kg/hl.

After being tempered to a moisture content of 14.0 percent, the samples were milled in a Bulher 3 breaks-3 reduction laboratory mill. Flour extraction rates ranged from 38.1 to 55.6 percent, with an average of 46.1 percent. The low flour yields are closely correlated to the low test weights of the grain, since seed shrivelling greatly affects flour extraction rates.

CIMMYT's breeders continued to give a high priority to the improvement of seed type. During the 1973-74 winter cycle, 123 samples selected at CIANO under irrigation and sent to the laboratory for quality evaluation. This seed was less shrivelled, resulting in improved test weights ranging from 66.8 to 75.9 kg/hl, with an average of 71.2 kg/hl. Seventy percent of the lines had a test weight equal to or higher than 70 kg/hl. The improvement of triticale seed type, as reflected in higher hectoliter weights, resulted in an increased extraction of flour from the grain. These samples had flour yields ranging from 53.0 to 68.5 percent, with an average of 61.1 percent.

CURRENT STATUS OF GRAIN SHRIVELLING

Samples evaluated from the material selected during the 1982-83 winter season at CIANO had test weights of up to 79 kg/hl, with flour yields of as much as 77 percent. The improvement in flour extraction, no doubt, has been due in part to the selection pressure placed by breeders on triticale for grain plumpness; there have also been other contributing factors, however, such as the correct tempering of the grain before milling, which affects flour extraction rates.

As noted earlier, when the evaluation work was started, all the grain samples were tempered in the laboratory to 14 percent moisture content (i.e., no consideration was given to the variability in seed hardness). However, the number of lines with hard endosperm has increased in the newer germplasm. For this reason, we began to temper seed samples in 1980 according to the hardness of the grain, adding more water to lines with harder endosperm. This allows for a better separation of the bran from the endosperm, therefore increasing the flour extraction rates achieved with more recent samples.

CURRENT STATUS OF OTHER TRAITS

Breeders are meeting with considerable success in their efforts to reduce seed shrivelling in triticale. However, triticale grain suffers from other weaknesses that currently inhibit its use in the preparation of different products; over-all baking quality, the level of alpha-amylase activity, and gluten quality and quantity are some of the important features that need additional research.

Baking quality - After milling, flour from the eleven triticale lines selected at CIANO in 1971-72 was used to bake bread in two ways:

- Using the straight dough method that is followed in the CIMMYT laboratory for the preparation of bread from wheat flour;
- Using a "modified" straight dough method.

The main modification applied to our normal procedure consists of reducing the fermentation period to 105 minutes, 45 minutes less than the time required for bread made from wheat. When the shorter fermentation period was used, the loaf volumes associated with these "old" triticale lines increased an average of 80 cc. The highest loaf volume in this test was 625 cc and the lowest was 545 cc. It was also observed that the crumb of the bread had better characteristics when the shorter fermentation was used. This modification was implemented due to the high levels of alpha-amylase found in triticale grain (relative to bread wheat), especially from the cultivars available at that time.

Other modifications during baking were also introduced, such as higher yeast concentration and a lower fermentation temperature; these also helped to improve the baking quality of the old triticale lines. With these modifications, and with the progress made by breeders toward grain plumpness, there are now many triticale lines that render loaf volumes higher than 700 cc, when 100 percent triticale flour is used to make sandwich bread. There are, however, other types of bread which have been prepared in the laboratory using white triticale flour, with very good results. Among them are the French-type breads, such as baguettes and bolillos (the latter is a very popular bread in Mexico).

With regard to fermented breads, the best results so far have been obtained with mixtures of wheat and triticale flour. The high level of alpha-amylase found in triticale acts as malt, improving the loaf volume of the mixture. For instance, mixtures with 50 percent triticale flour give loaf volumes higher than those obtained with 100 percent wheat flour.

Preparation of products with whole triticale flour is another important aspect, since triticale has a better aminoacid balance than wheat. A number of products can be prepared with whole triticale flour. Chapatis of acceptable quality can also be prepared from triticale; their color is a little darker, since they are usually prepared with whole flour. Chapatis prepared from triticale keep well; 72 hours after cooking, their softness can be recovered by warming and they are quite edible. Chapatis are a very important food in such countries as India and Pakistan, and it should not be very difficult to develop triticales with white grain (a more appropriate color for this potential use).

Triticale has been shown to be very good for the preparation of other non-fermented products, like cookies, cakes, biscuits and pancakes. These products require low protein, low water absorption, and doughs with minimal resistance to extension. Triticale should be promoted for the preparation of such products, as well as for those prepared with whole triticale flour, for they can be produced without modifications in baking technology.

Alpha-amylase activity - The "old" triticale lines of the early to mid-1970s, when grown under rainfed conditions, had the tendency to sprout before harvest. As a result of this early emergence, the alpha-amalyse content was very high, affecting adversely the baking quality of these lines. This is why the baking method was modified. Nevertheless, even with modifications in the bread baking process, the alpha-amylase enzyme dextrinizes a great proportion of the starch, resulting in a very sticky crumb in the bread.

Selection pressure is being placed on early generation material for lower levels of alpha-amylase. This selection process started in the 1973-74 season, when all the segregating material was first evaluated for this characteristic by using the falling number method. This procedure is a fast and accurate means for determining the level of enzyme activity; values can run as low as 60, indicating that there has been some degree of sprouting activity. Triticale lines with low falling numbers (or high alpha-amylase activity) are discarded. Through this kind of evaluation, a number of lines with falling numbers of up to 250 seconds were identified among the materials selected during the 1983 summer cycle. This indicates that improvement for this character can be achieved; choosing the proper parental material is essential, and growing segregating lines under rainfed conditions greatly facilitates selection.

Gluten strength and quantity - To make triticale more suitable for the preparation of bread and other baking products, improvements in both the quality (strength) and quantity of its gluten are required. While the loaf volumes of some triticale lines have increased considerably as a result of greater gluten strength, more work is needed to produce triticales with stronger gluten.

The Pelshenke (dough ball) test was first used to evaluate individual plants in segregating material for gluten strength. Among the triticale lines of a decade ago, there was little variability; nearly all of the plants had very weak gluten. After four years of improvement work, some of CIMMYT's triticale lines had stronger gluten, and through years of intercrossing this material, advanced lines with greater gluten strength are being obtained; these new lines are precisely those giving higher loaf volumes. At the present time, individual plants from the F_5, F_6 and F_7 generations are screened for gluten strength using the micro-sedimentation method.

Another problem with triticale is its gluten content. Because it is a cross between wheat and rye, many triticale lines have a very small amount of gluten, like the rye parent. Since gluten content is a very important characteristic, especially in baking, all advanced lines are being evaluated for this trait. Selections are made for higher amounts of gluten, and the better of these lines are incorporated into the crossing block as parental material so as to continue increasing the amount of gluten.

Protein - Ten years ago, practically all triticale lines showed a high protein content. This trait was unfortunately associated with shrivelled seed. The seed of our more recently developed lines is plumper and well filled, hence the protein content has decreased. Breeding is now underway to raise the level of protein in our much improved triticales to improve the industrial quality of the crop.

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High molecular weight glutenin subunits in seed of triticale and its parental species

G. BRANLARD, D. BARLOY

INRA, Station d'Amélioration des Plantes
Domaine de Crouelle, 63039 Clermont-Ferrand, France

INTRODUCTION

High molecular weight glutenin subunits of bread wheat have a molecular weight of between 140 000 and 90 000. Study of 195 French bread wheat cultivars enabled us to observe 20 subunits, each cultivar having 3 to 5 proteic bands. These subunits are coded by genes situated on the long arm of chromosome 1A, 1B and 1D. Many of these subunits play a basic functional role in bread wheat quality. Knowledge of the diversity of these proteins for Triticum durum, rye and triticale should permit improvement in the technological quality of triticale.

MATERIALS

High molecular weight (H M W) Glutenin subunit electrophoresis has been carried out with the following material :

32 triticale genotypes originating from 13 countries, supplied by Dr BERNARD ;

7 rye genotypes, obtained after 29 sib crosses ;

4 rye populations

95 durum wheat cultivars from a world collection, kindly provided by Drs AUTRAN and MONNEVEUX.

METHODS

Electrophoresis of high molecular weight glutenin subunits :

After removal of its embryo, the grain is ground in a mortar. 10 mg of the flour obtained is put in an Eppendorf tube in which is added an extraction solution containing SDS : 3 %, Glycerol : 15 %, 2 mercapthoéthanol : 7.5% and buffer Tris HCl pH 6.8 : 9.4 %. The extraction lasts 2 hours at ambient temperature, and is followed by 5 mn in a double boiler at 95°C.