A major objective of the hard red winter wheat (Triticum aestivum L.) breeding programs is to improve flour quality for use in making bread. Quality characteristics required by the baking industry demand cultivars possessing relatively long dough mixing time, good mixing tolerance, good loaf volume and superior internal properties. Single, simple tests that accurately estimate the quality of hard red winter wheats have not been devised. For complete analysis more grain is required than is available during early segregating generations of a cross. Furthermore, a number of characteristics determine baking quality of hard red winter wheat, and a final analysis can be made only by milling and baking trials.

This manuscript reports information from studies conducted during the period 1939–1957. Most of the data were lost in a fire in 1957. Preliminary reports have been presented\(^3\)\(^4\) (5).  

## MATERIALS AND METHODS

Four hard red winter wheat varieties were used as parents in crosses; their quality characteristics are given in Table 1. 'Chiefkan' has low quality and 'Tenmarq', 'Comanche', and 'Cheyenne' have above average quality characteristics for hard red winter wheat. The crosses studied were Tenmarq × Chiefkan, Comanche × Chiefkan, and Cheyenne × Chiefkan.

The crosses were made using Chiefkan as male to facilitate the identification of F\(_1\) plants since Tenmarq, Comanche, and Cheyenne are bearded and Chiefkan is awnleted. The awnleted condition is dominant and positive identification of F\(_1\) plants was possible when the bearded parent was used as the female. The material was studied in the following manner:

### Generation Treatment

- **F\(_1\)**: Plants were spaced 3 inches apart in rows 1 foot apart to produce about 1600 grams of seed for milling and baking studies. Fifty plants of each parent were studied in detail. 1940.
- **F\(_2\)**: Space planted, about 500 plants from each cross. 1941.
- **F\(_3\)**: Planted progeny of all F\(_2\) plants of each cross and determined the wheat meal fermentation time. 1942.
- **F\(_4\)**: Replanted all F\(_3\) lines and determined wheat meal fermentation time. Planted in quantity 20 lines (as the bulk progeny of an F\(_2\) plant) for determining water absorption time and hydration capacity. Five lines with short fermentation time, 10 with medium time, and 5 with long time.
- **F\(_5\)**: The 60 lines increased in F\(_4\) were grown to provide 1600 grams of grain for each line. Complete experimental milling and baking data were obtained on the F\(_2\) progeny lines and parents. 1944.
- **F\(_6\)**: The 60 F\(_2\) progeny lines were grown again and quality studies were repeated. Ten plants were selected at random from each of the 60 lines. 1947.
- **F\(_7\)**: Increased seed of the plants selected in F\(_6\). No quality tests made. 1948–49.

### Table 1. Quality characteristics of hard red winter wheats used as parents.

<table>
<thead>
<tr>
<th>Variety</th>
<th>CI no.</th>
<th>Wheat meal fermentation time</th>
<th>Mixing time</th>
<th>Baking characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiefkan</td>
<td>11754</td>
<td>short</td>
<td>short</td>
<td>low</td>
</tr>
<tr>
<td>Tenmarq</td>
<td>1936</td>
<td>long</td>
<td>long</td>
<td>high</td>
</tr>
<tr>
<td>Comanche</td>
<td>11873</td>
<td>long</td>
<td>long</td>
<td>very high</td>
</tr>
<tr>
<td>Cheyenne</td>
<td>8885</td>
<td>medium</td>
<td>very long</td>
<td>medium</td>
</tr>
</tbody>
</table>

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2. Agronomist, Kansas State University, and Research Chemist, CRD, ARS, USDA. The authors acknowledge the help of Stanley Wearden, statistician, Kansas State University.
