NOTE

Time-Dependent Moisture Gradients in Conditioned Wheat, Determined by Electrical Methods

Y. POMERANZ and L. C. BOLTE, U.S. Grain Marketing Research Laboratory, U.S. Department of Agriculture, Agricultural Research Service, Manhattan, KS 66502; and S. AFEWORK, Department of Chemical Engineering, Kansas State University, Manhattan 66502

ABSTRACT

Water penetration during wheat conditioning and subsequent moisture content changes were determined. Four electrical moisture meters were used to determine moisture contents in grain on the basis of dielectric, capacitance, impedance, and conductance properties. The differences between actual moisture content and moisture determined by each of the electrical methods decreased as the time after water addition increased. The differences were largest for the conductance and smallest for the capacitance method. The differences were attributable to moisture gradients in the wheat. The rate of water penetration, according to moisture determined by the conductance method, was rapid in soft red winter wheat, slow in durum wheat, and intermediate in hard red winter wheat. Water distribution in the wheat kernel, as determined by conductance, was stabilized in 2–4 hr after water addition, depending on the kernel hardness.

The objective of this research was to determine the rate of water penetration into wheat by following changes in apparent moisture content, as determined by several electrical methods. The study was based on the observation that conductance is greatly affected by the extent of moisture penetration into and moisture distribution in the conditioned wheat kernel. This moisture gradient in freshly conditioned wheat makes it impossible to determine the true moisture content by some electrical methods. A comparison of moisture contents in conditioned wheat, as determined by the conductance method and the capacitance method, was useful, however, in following the rate of water penetration.

MATERIALS AND METHODS

Four hard red winter, two soft red winter, and two durum wheats were used. Their partial characterization is given in Table I. The wheats were conditioned to contain 15% moisture at 21.1°C (70°F) in the apparatus described by Bequette and Barmore (1963). Three-kg samples were conditioned and blended, and duplicate subsamples were drawn at appropriate intervals and analyzed. Moisture (by the air-oven drying method) and protein (by the Kjeldahl method) were determined, according to AACC approved methods (1976) on material ground on a laboratory Hobart mill, and wheat hardness was measured by the NIR reflectance method (Bruinsma and Rubenthaler 1978, Miller et al 1982) on material ground on a Udy mill.

The rapid electric meters used to follow moisture penetration and principles of their operation were: DICKEY-john GAC II-

<table>
<thead>
<tr>
<th>Class and Variety</th>
<th>Test Weight (lb/bu)</th>
<th>Average Kernel Weight (mg)</th>
<th>Moisture (%)</th>
<th>Hardness (NIR at 1,680 nm)</th>
<th>Protein (N × 5.7, 14% mb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft red winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hart</td>
<td>56.8</td>
<td>32.3</td>
<td>10.6</td>
<td>131</td>
<td>14.4</td>
</tr>
<tr>
<td>Pike</td>
<td>56.5</td>
<td>29.0</td>
<td>10.9</td>
<td>111</td>
<td>12.7</td>
</tr>
<tr>
<td>Hard red winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newton</td>
<td>58.4</td>
<td>25.2</td>
<td>11.8</td>
<td>200</td>
<td>12.3</td>
</tr>
<tr>
<td>Scout 66 (A)</td>
<td>57.4</td>
<td>26.6</td>
<td>12.3</td>
<td>208</td>
<td>13.3</td>
</tr>
<tr>
<td>Scout 66 (B)</td>
<td>58.5</td>
<td>26.4</td>
<td>10.6</td>
<td>211</td>
<td>13.8</td>
</tr>
<tr>
<td>Lared</td>
<td>59.6</td>
<td>32.2</td>
<td>10.5</td>
<td>192</td>
<td>13.4</td>
</tr>
<tr>
<td>Durum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cando</td>
<td>58.2</td>
<td>29.5</td>
<td>9.5</td>
<td>251</td>
<td>13.6</td>
</tr>
<tr>
<td>Vic</td>
<td>58.7</td>
<td>58.1</td>
<td>12.5</td>
<td>290</td>
<td>13.4</td>
</tr>
</tbody>
</table>

1 Cooperative investigations between USDA-ARS and the Kansas Agricultural Experiment Station, Kansas State University.

2 Mention of firm names or trade products does not constitute endorsement by the U.S. Department of Agriculture over others not mentioned.

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RESULTS AND DISCUSSION

Moisture was determined by four electrical methods in two hard winter wheat cultivars, Newton and Scout 66, 15 min to 16 hr after tempering to 15% moisture. Averages of analyzing duplicate subsamples are shown in Figs. 1 and 2. Differences between the moisture contents determined by any of the electrical methods and the actual, 15%, moisture content of conditioned wheat decreased as the time after tempering increased and presumably, as water was distributed more evenly throughout the kernel. This difference was largest for the conductance method and decreased in order for the dielectric, impedance, and capacitance methods. These results are consistent with the finding that capacitance methods are least affected and conductance methods are most affected by nonuniform moisture distribution in the wheat kernel.

Effects of grain hardness on the rate of water penetration in durum, hard red winter, and soft red winter wheats are shown in Fig. 3 A and B. Water penetration was fastest in the two soft red winter wheat cultivars, Hart and Pike; intermediate in the two hard red winter wheats, Scout 66 and Larned; and slowest in the two durum wheats, Vic and Cando. Water distribution in the wheat kernel, as determined by conductance, was stabilized in 2-4 hr after water addition, depending on wheat hardness. More extensive studies are required to determine to what extent kernel size, original moisture, and protein contents affect the rate of water penetration. No consistent effects were recorded for the samples used in this study.

The value of determining the rate of water penetration into the wheat kernel is primarily as an index of conditioning time required for wheat in the milling process. The results of such a study have been published elsewhere (Pomeranz et al 1984).

LITERATURE CITED


ANONYMOUS. 1977. The importance of conditioning Australian wheat for milling. Wheat Australia 10(5):2


BRUINSMA, B. L., and RUBENTHALER, G. L. 1978. Estimation of


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