NOTE

Rapid and Simple Detection of a Mixture of Wet and Dry Corn[1]

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ABSTRACT

The presence of corn kernels that differ about 6% in moisture can be detected within 24 hr after blending. The detection is based on comparison between moisture determined by the conductance Tag-Heppenstall and oven drying or between the conductance and other electrical methods.

The problems associated with blending grain shipments that vary widely in moisture content are well recognized (Scheid 1985). They include hazards of mold infection (Lillehoj et al 1976, Sauer and Burroughs 1980, Tuite et al 1985) and increased breakage susceptibility (Nguyen et al 1984). In well-mixed and aerated samples, moisture equilibration is fairly rapid (Fisher and Jones 1939, White et al 1972) and, depending on several factors, can be attained within 48 to 72 hr. But even under favorable conditions, there is a hysteresis effect, and a residual difference of about 0.25–0.75% can be recorded in individual corn kernels even after weeks (Hart 1964). Some authors proposed detecting mixtures of artificially dried corn with high-moisture corn by determining moisture in single kernels (Hart 1967, Watson et al 1979). Such methods are time-consuming and fraught with many difficulties that stem from the low precision of assaying rapidly and accurately moisture in individual kernels, sampling error, and the natural variation in moisture of individual kernels with a common history. We report a simple and fairly rapid method for detecting blends of corn varying widely in moisture content. The detection is based on a dual determination of moisture, i.e., by oven drying and conductance (electrical meter) or by two electrical methods and the difference in results from the two methods.

MATERIALS AND METHODS

The studies were conducted on two corn hybrids, BoJac-X603 and Pioneer 3377. Grain from each hybrid was combine harvested and hand shelled. The combine- and hand-harvested samples were obtained on the same day for corn with a moisture content of about 20%.

In hand harvesting the corn, 50 to 60 ears were picked from each hybrid, one for every six rows and one ear for every 10 m in the row. The corn was immediately placed in plastic bags and brought to the laboratory where it was hand shelled. The hand-shelled corn was mixed and divided into two parts using the Boerner divider. One part, about 8 kg of wet corn, was placed in closed hard plastic jars and then in a cooler at about 2° C. The second part of the hand-shelled corn was spread on trays and left at a room temperature of approximately 22° C to dry to 12.0–12.5% moisture.

About 8 kg of freshly combine-harvested corn of both hybrids was brought to the laboratory, and broken corn and foreign material (BCFM) were removed. BCFM for BoJac-X603 and Pioneer 3377 was 1.7% and 2.0%, respectively. Each BCFM-free hybrid was placed in a cooler at 2° C. To lower the moisture of the combine-harvested corn to 12–13%, the grain was air dried in a bin for five days. During drying, the ambient temperature for BoJac-X603 was approximately 20° C with a relative humidity of 70%, and for Pioneer 3377 approximately 15° C with a relative humidity of 65%. After five days, about 8 kg of each hybrid was removed from the bottom of the bin and brought to the laboratory; BCFM removed was similar to that in the freshly combine-harvested material.

Four experiments were conducted on blended corn from the material described above. The blends consisted of wet/dry hand-shelled and wet/dry combine-harvested corn for each hybrid. The wet samples of corn from the cooler were held 24 hr to reach room temperature and were then blended with the dry corn samples. Blends of 7–10 kg were distributed into glass jars of equal volume containing 2.5 kg corn. The closed jars were rolled mechanically for 1 hr. The jars with the thoroughly blended corn were kept at room temperature, and the moisture level was determined periodically during 144 hr using electrical moisture meters and the oven method.

The test weight, percent damage, and moisture contents (oven dried) of the samples are given in Table I. The high and low moisture samples were mixed to produce the blends with the following moisture levels: BoJac-X603 hand shelled, 14.6%; combine harvested, 15.0%; and Pioneer 3377 hand shelled, 14.4%; combine harvested, 15.0%.

Percent mechanical damage was determined by the green dye method of Chowdury and Buchele (1976) as modified by Pomeranz et al (1986). Whole kernels were analyzed for moisture by the ASAE oven method (ASAE 1982).

In addition, four rapid electric meters were used to determine moisture (Pomeranz et al 1984): Dickey-John GAC II-dielectric (Dickey-John, Inc., Auburn, IL), Motomco moisture meter model 914, capacitance (Motomco, Inc., Patterson, NJ), Steinlite moisture tester, electronic, impedance type 6 (Seedburo Equipment Co., Chicago, IL), and Tag-Heppenstall moisture meter, conductance, model 8004, type 14 (Weston Electrical Instruments Corp., Newark, NJ).

All determinations were made on triplicate subsamples. All results were averaged for use in this report.

RESULTS AND DISCUSSION

Test weight, percent of damaged kernels, and moisture of the freshly harvested and dry samples are listed in Table I. Drying increased the percent of mechanically damaged kernels (especially in Pioneer 3377). Both in the hand-picked and shelled and in the combine-harvested samples, drying increased the test weight.

Determinations of moisture by the oven and four electrical methods in the hand-shelled and combine-harvested two hybrids are compared in Figure 1. Within the first 24 hr after blending there

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TABLE I
Moisture Contents[a] of Hand-Picked and Shelled and Combine-Harvested Corn Used in Preparation of Blends

	Test Weight (lb/bu)		Mechanically Damaged Kernels (%)		Moisture (%)	
Sample	**BoJac-X603**	**Pioneer 3377**	**BoJac-X603**	**Pioneer 3377**	**BoJac-X603**	**Pioneer 3377**
Hand picked						
At harvest	58.5	58.1	···	···	20.18	18.18
After drying[b]	62.3	60.7	···	···	12.53	11.92
Combine harvested						
At harvest	57.2	55.6	30.1	26.0	19.44	19.07
After drying[c]	60.7	58.7	32.8	51.1	12.92	12.40

[a] By oven drying.
[b] Dried on trays at room temperature in the laboratory.
[c] Dried in a commercial bin.

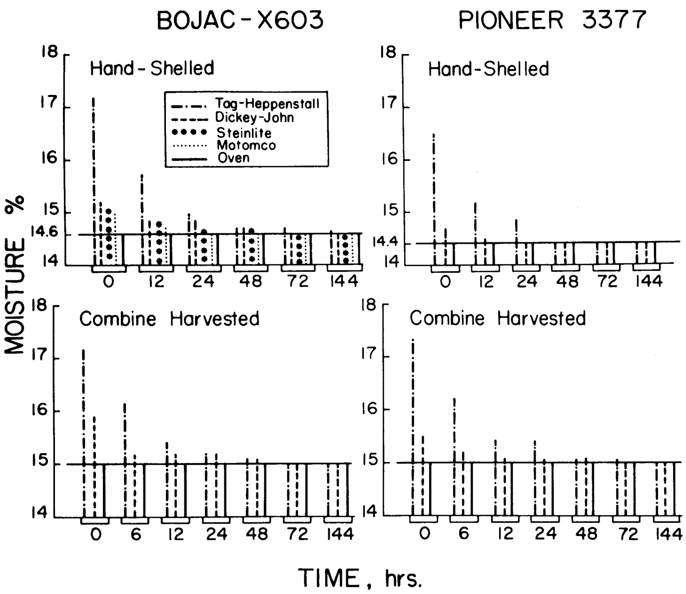

Fig. 1. Moisture in hand-shelled and combine-harvested BoJac-X603 and Pioneer 3377 corn hybrids, as determined by oven drying and four electrical moisture meters at various times after blending of corn samples that varied widely in moisture. The electric meters were Dickey-John dielectric, Motomco capacitance, Steinlite impedance, and Tag-Heppenstall conductance.

was a large difference between moisture determined by the oven and Tag-Heppenstall methods. The difference between the oven and the other three electrical methods was smaller. After 48 hr, the moisture values for the various methods were comparable.

The results of this preliminary study indicate that it is possible to detect by a simple method whether a lot of corn has been prepared within 24 hr from blends that differ widely in moisture contents. The detection is based on comparison between moisture determined by the conductance Tag-Heppenstall method and oven drying or between the conductance and other electrical methods. Whereas the conductance method measures moisture in a fine stream of slowly crushed grain (and therefore is affected by distribution of moisture among individual kernels), the other electrical methods and, especially, the oven-drying procedure measure moisture in the bulk sample.

An ideal solution to the problem would be a dual-reading electrical instrument (i.e., conductance and capacitance) that shows no differential reading between the two types of instruments in an equilibrated sample, and in the case of blended samples, which shows a differential, the magnitude of which depends on the difference in moisture between the components of a blend. Alternatively, two instruments (i.e., Tag-Heppenstall and a capacitance meter) can be calibrated to give the same reading for corn of about 15% moisture and known to be from a uniformly dried lot. Samples of unknown origin and history can then be tested by the nondestructive capacitance method followed by the conductance method. A large discrepancy in readings between the two methods would indicate a blend of samples varying widely in moisture contents. Studies involving both approaches are underway in our laboratories.

The length of time during which blending can be detected will likely depend on the difference in moisture between the components of the blend, thoroughness of mixing and aeration, temperature, history, and inherent properties of the corn. All these factors will affect equilibration of moisture among the components of the blend. Consequently, the difference in moisture as determined by the conductance and the other methods is a reflection of the rate of equilibration.

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