NOTE

# Use of an Electrical Conductance Moisture Meter to Study Tempering Rates in Grain Sorghum[1]

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Grain is often tempered before being ground or decorticated. Tempering involves the addition of water, followed by a rest period (Cleve 1954, Gillespie 1948). For wheat, tempering toughens the bran, allows a cleaner separation of bran and endosperm (Briggs 1925), and increases the friability of the endosperm particles (Butcher and Stenvert 1973).

The effects of tempering on milling are not completely understood, but adding moisture to grain causes the germ to swell and to pull away from the endosperm (Martin 1970, Sorenson and Person 1970). The factors affecting proper conditioning of the grain before milling are the amount and distribution of water in the kernel (Anonymous 1957, Bradbury et al 1960), which, in turn, are affected by the amount of water added to the grain, the water temperature, and the time allowed for water to penetrate the kernel (Kuprits 1965).

The rate at which water penetrates grain affects the time needed for tempering, and this must be considered when different grain lots are mixed (Baker 1935, Blessin et al 1962). Fraser and Haley (1932) found that the amount and rate of water absorption by wheat was affected by wheat variety, tempering time and temperature, and kernel size. Scouring the grain increased water absorption; the percentage of protein in wheat had a minor effect on water absorption.

Little work has been done on the uptake of water by grain sorghum. Recording weight gains during tempering, Fan et al (1963) found that the initial weight gain was rapid but decreased gradually with time. They reported that the diffusivities of water in corn and sorghum were of the same order of magnitude as those in wheat. Others have found that hard sorghum absorbs moisture more slowly than does soft sorghum (Weinecke and Montgomery 1965) and that waxy sorghum cultivars absorb more water than do nonwaxy cultivars (Mustafa 1969).

Our objective was to study the rate at which water penetrates sorghum kernels during tempering by using autoradiography and an electrical conductance moisture meter.

## MATERIALS AND METHODS

### Materials

A commercial, low-tannin sorghum (DeKalb E59) grown in Kansas in 1978 was used. After the grain had been cleaned on the model XT2 Carter dockage tester (Hart-Carter Co., Minneapolis, MN), it was scoured lightly with an experimental scourer to remove the dust on the grain surface without affecting the pericarp. The light debris was removed with a model FC9 Kice aspirator (Kice Metal Products, Co., Wichita, KS). The cleaned grain had a test weight of 59.8 lb/bu and a 1,000-kernel weight of 24.9 g. One sample from the same lot of grain contained 9.1% protein (N × 6.25), 3.3% fat, 1.5% ash, and an initial moisture content of 12.5%. Another subsample had initial moisture of 10.8%.

### Water Penetration into Sorghum Kernels

Water penetration was studied with a Tag-Heppenstall (style G.R.) electrical conductance moisture tester (C. T. Taniabue, Brooklyn, NY). The tester consists of a pair of corrugated rolls with 28 corrugations per inch. The distance between the rolls was adjusted with shims marked for use with sorghum.

When sorghum passes between the rolls, it is gripped by the rolls and slightly crushed and thus acts as a path for the electric current. From the current (I) that has passed through the sorghum, the resistance (R) of sorghum is determined by Ohm's Law ($I = E/R$), where E is the voltage used. The resistance is inversely proportioned to the moisture content. By measuring the decrease in apparent moisture in the outer layers of the grain at regular time periods, the rate of entry of the water into the kernel is determined.

Sorghum (3,000 g) was tempered to different moisture levels (15, 16, 17, and 18%). The amount of water required to attain each level was mixed with the grain in a rotating steel drum for 5–10 min to allow water on the surface to be absorbed. Each sample was then transferred to an aluminum can and capped. A small sample from each can was tested in the moisture meter at various times after the initial introduction of water to the grain.

An autoradiographic technique (Jackson and Varriano-Marston 1980) also was used to determine the rate and pattern of moisture uptake. Sound kernels (30) were placed in glass vials, and 0.2 ml of tritiated water (50 mCi/ml) was added to each vial. The vials were shaken and then stored at 25°C for 1–3 hr. After a designated time, sorghum kernels were washed with distilled water to remove excess tritiated water that might contaminate the kernel surface during cutting. They were then cut with a razor blade, mounted in pithwood, and frozen in liquid nitrogen. Half-kernels were taped to prefrozen strips of NMB film (Kodak) and exposed for 24 hr at −78°C. Following exposure, kernels were removed from the film, and the film was developed in Kodak D-19.

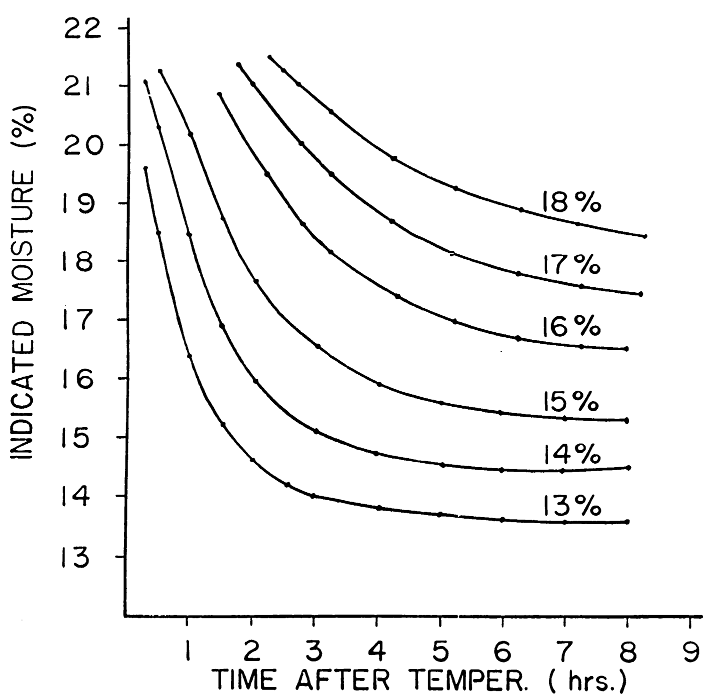


**Fig. 1.** Effect of tempering moisture level and time on the absorption of water by grain sorghum having an initial moisture content of 10.8%. Moisture content measured with Tag-Heppenstall meter (wet basis).

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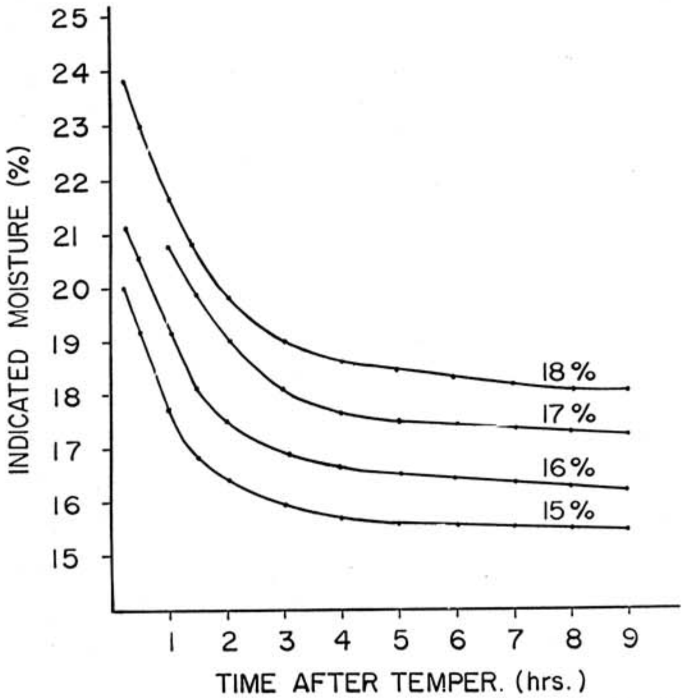


**Fig. 2.** Effect of tempering moisture level and time on the absorption of water by grain sorghum having an initial moisture content of 12.5%. Moisture content measured with Tag-Heppenstall meter (wet basis).

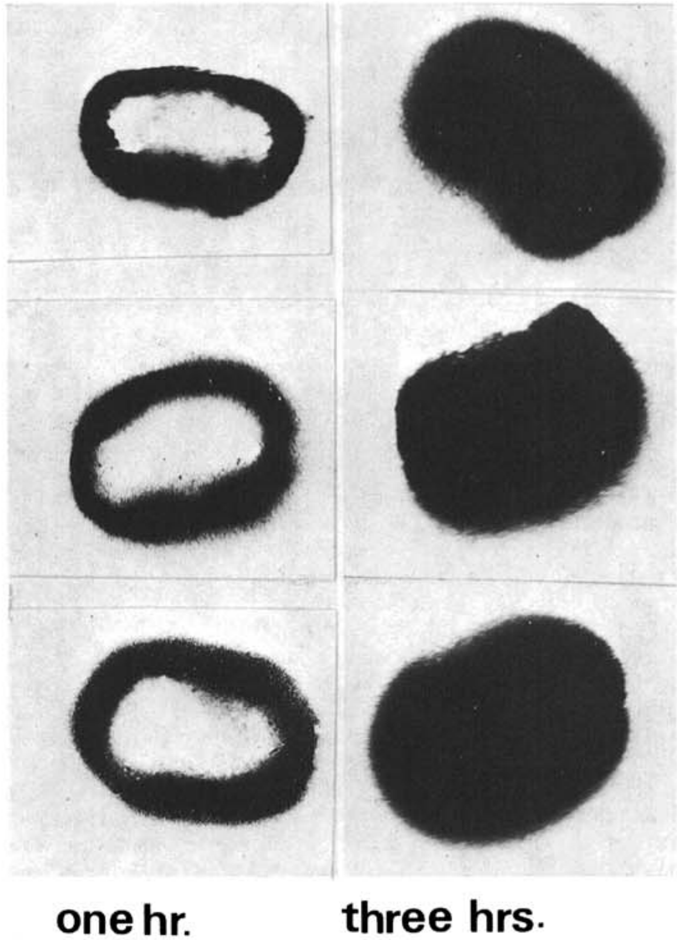


**Fig. 3.** Autoradiograms showing extent to which tritiated water had penetrated sorghum kernels after 1 and 3 hr of tempering. Darkened areas indicate penetrated water.

## RESULTS AND DISCUSSION

The rates at which water penetrated sorghum kernels, as determined by the moisture meter, are presented in Figs. 1 and 2. Because nearly all added water was initially on the surface of the kernels, the initial reading indicated a much higher moisture percentage than that of the tempered kernels. Initial moisture content of the grain had an effect on the rate that water penetrated the grain during the first 2 hr of tempering. Grain with an initial moisture content of 12.5% (Fig. 2) absorbed water faster than did grain having an initial moisture content of 10.8% (Fig. 1).

As time progressed, the moisture on the surface was absorbed into the kernels. Water initially penetrated rapidly; after 3 hr most of the water had adsorbed into the kernel. Thereafter, water penetration was slow and was not affected by initial grain moisture content.

Autoradiographic data showed similar trends as those obtained on the conductance meter. The extent to which tritiated water had penetrated individual kernels after 1 hr and 3 hr is shown in Fig. 3. After 1 hr the water was confined to the outside layers of the kernel, but after 3 hr water was distributed throughout the entire kernel. The autoradiograms suggest that the structures of the pericarp do not delay water penetration into the grain; ie, the rate of penetration through the bran is the same as through the germ. Similar results were reported for wheat by Jones (1949). Comparison of our data with similar autoradiographic studies on wheat kernels (Jackson and Varriano-Marston 1980) indicated that water penetrated our sorghum sample more rapidly than it did some wheats.

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