

EFFECT OF ARTIFICIAL DRYING ON THE HYGROSCOPIC PROPERTIES OF CORN¹

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ABSTRACT

The equilibrium moisture content (EMC) and the equilibrium relative humidity (ERH) of shelled corn artificially dried in a pilot dryer and in the laboratory were determined. Samples dried at air temperatures of 140°F. and above adsorbed less water at relative humidities of 70–80% than those dried at lower temperatures. The ability to adsorb moisture progressively decreased with increased drying temperature. The effect seems to be permanent with case hardening not substantially involved. Corn dried with temperatures of 140°F. and above supported a higher ERH than corn of the same moisture dried with room air. The increase in ERH with increased drying temperature was ~~proportional~~ proportional to the decrease in EMC. The other variables in the drying treatments — airflow rates, batch and continuous-flow drying methods, and initial corn moisture — did not significantly affect EMC or ERH.

Artificially dried corn with its higher interseed relative humidity should be stored at 0.5 to 1% lower moistures than naturally dried corn to prevent mold development. The moisture content and the ERH of a sample of corn can be readily determined and may be useful in indicating previous drying history and in the evaluation of drying methods.

Warehousemen have reported difficulty in the storage of artificially dried corn. Bailey (1) reported that "Increases in blue-mold damage to corn stored in a terminal elevator usually, but not always, take place with artificially dried corn." He reports further that the spread of mold in naturally dried corn is "much slower than in artificially dried grain."

Studies of the effect of artificial drying on the market quality and storability of field-shelled corn were initiated in 1959 under a joint project of the Purdue University Agricultural Experiment Station and the USDA Agricultural Marketing Service. This paper reports on changed hygroscopic properties of dried corn that are probably related to storage behavior and other quality factors.

Equipment and Methods

Drying Treatments. The drying studies extended over three crop years and included tests in the laboratory and in a pilot drying plant. Three commercial hybrids grown on the Purdue University Agronomy

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Electric meters were used to determine moisture levels of large lots of corn prior to final drying treatment. Moisture contents were also calculated using weight changes from a previously determined moisture level. Moistures are reported on a wet basis.

Relative Humidity Measurements. The relative humidity in the interseed air was measured in corn of known moisture levels and related to the method of drying. One or more electric hygrometer elements (4) of suitable range were placed in a closed container of corn and the relative humidity read periodically with an indicating instrument. Accuracy of the elements when checked over the salt solutions listed above was close to $\pm 1.5\%$ as specified by the manufacturer.

Discussion and Results

Equilibrium Moisture Content (EMC). Observations on the EMC of artificially dried grain were made on samples from the pilot dryer in 1959. The moisture contents of corn stored at 80% r.h. and 73°–76°F. for 5 weeks were:

| | <i>Average Equilibrium Moisture Content</i> |
|--|---|
| | % |
| Nine control samples dried at room temperature | 15.52 |
| Nine samples dried at 140°, 190°, or 240°F. | 15.07 |

The difference of 0.45% in equilibrium moisture content was significant at the 0.01 level. The two-stage air oven method was used for moisture determinations.

Samples of corn dried without heat were autoclaved (250°F. for 15 min.) and compared to similar samples not autoclaved (Table I). The

TABLE I
EQUILIBRIUM MOISTURE CONTENT OF AUTOCLAVED AND NONAUTOCLAVED CORN AS DETERMINED AFTER 10 WEEKS' STORAGE AT 75 AND 80% R.H. AND AT 73° TO 77°F.

| TREATMENT | ORIGINAL MOISTURE CONTENT | STORAGE RELATIVE HUMIDITY | EQUILIBRIUM MOISTURE CONTENT ^a | |
|---------------|---------------------------------|---------------------------------|---|--------|
| | | | Air Oven ^b | Weight |
| | % | % | % | % |
| Nonautoclaved | 11.8 | 75 | 14.5 | 14.4 |
| Autoclaved | 12.2 | 75 | 13.2 | 13.3 |
| Nonautoclaved | 12.8 | 80 | 15.7 | 15.4 |
| Autoclaved | 13.1 | 80 | 14.2 | 14.0 |

^a Average of three replicates.

^b Determined by the two-stage air oven method.

autoclaving lowered the EMC from 1.1 to 1.5 percentage points.

Small samples of corn from the 1960 crop were dried from 23.0% to about 13% moisture in the laboratory at air temperatures of 80°,

used for moisture measurements on the ground corn and may account for the lower moisture, but the same relationship between equilibrium moisture content and drying temperatures exists for whole and ground corn. Thus, case hardening is little involved in the decreased moisture adsorption of corn dried with heat.

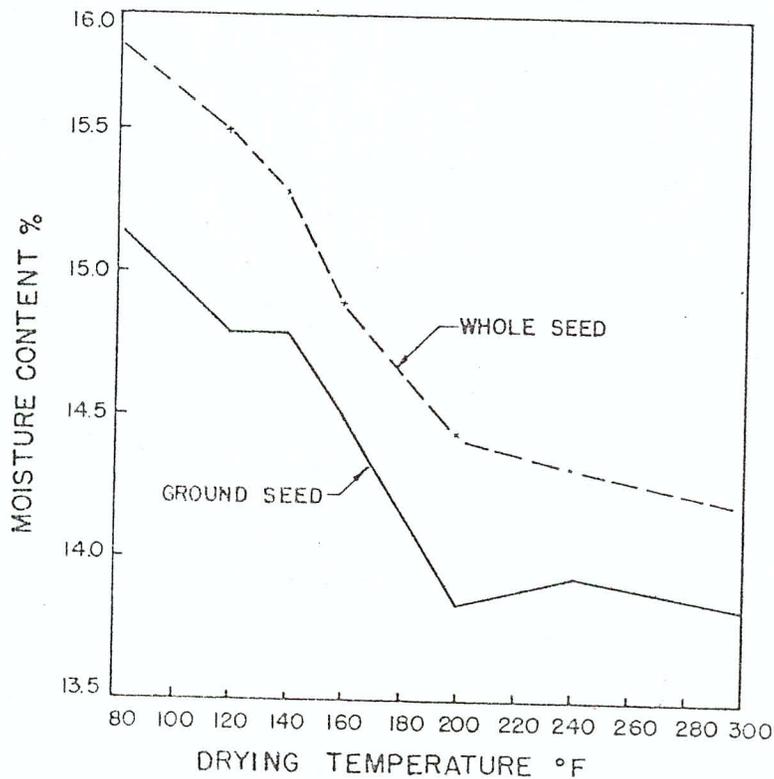


Fig. 2. Equilibrium moisture content of corn dried at various temperatures and stored whole and ground for 5 weeks at 80% r.h. and 80°F.

Brandenburg and Harmond (2) report a shift in the EMC of the straw of fiber flax dried with heated air that was independent of case hardening.

Observation on EMC was concluded with samples from the 1961 crop dried in the pilot dryer. The average and the range of the moisture contents of the samples after exposure to 80% r.h. and 80°F. for 1 month are in Table II. Temperatures of 140°, 190°, and 240°F. resulted in average reductions in the EMC of 0.4, 0.7, and 0.8%. The differences from the control were significant at the 0.01 level. Variables other than temperature — airflow rate, initial moisture level, and drying method — affected the average equilibrium moisture level 0.1% or less, and were not significant.

Since the two-stage oven method was used to determine moisture

separate gallon cans and held at 77°F. Within 24 hr. the interseed relative humidity was 62% for the lot dried at 160°F. and 55% for the lot dried at 80°F. A week later the difference in the two humidities was reduced to 5% and after one month to about 4%. After 19 months the difference in relative humidity was about 3%.

The relative humidity supported by corn was similarly determined for the samples dried in the second laboratory test (Fig. 3). As expected, the ERH increased as the drying temperature increased. The effect of drying temperature on ERH is about inversely proportional to the effect on EMC (Fig. 2).

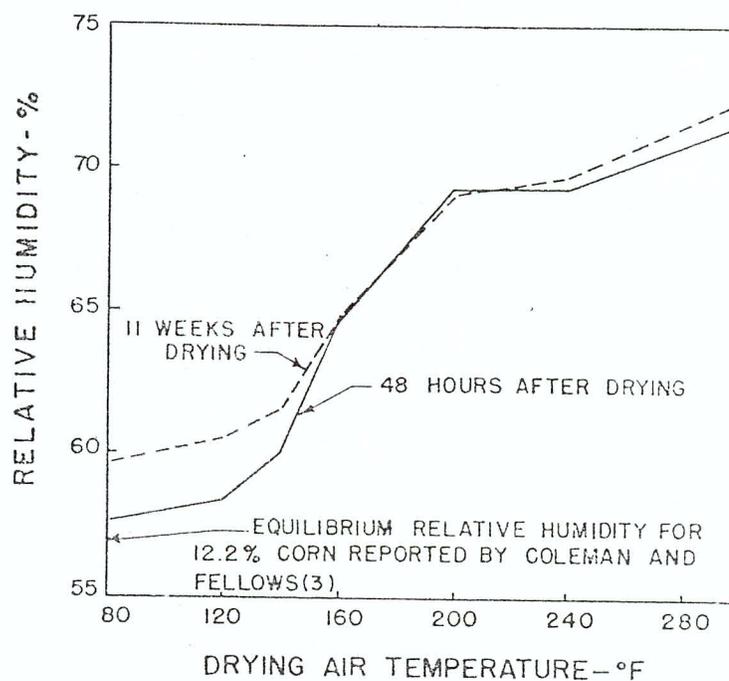


Fig. 3. Effect of drying air temperature on the relative humidity of interseed air in equilibrium with corn dried to 12.2% moisture.

The equilibrium relative humidities were studied with 12% corn to enable observation over extended periods without mold growth confounding results. Since the equilibrium moisture contents were studied in the range of 13.5 to 15.5%, the ERH of two samples dried to 14% moisture content — one with 80°F. drying air and one with 200°F. drying air — were compared. The difference in the relative humidity supported by these two samples was 8% about 48 hr. after drying, only slightly less than that with 12% corn.

Some of the relative humidities supported by the samples changed with time. In the test with the 1-gal. samples the humidity in the sample dried at 80°F. slowly increased and the difference between the