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A CABINET WITH CONTROLLED HUMIDITY TO BRING CEREAL SAMPLES TO CONSTANT MOISTURE

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16. Abstracts

Laboratories engaged in the analyses of cereal products often spend large amounts of time for the determination of moisture. If analyses need not be determined immediately, a moisture equilibration cabinet can be used to bring samples to a uniform moisture content. ~~This arrangement is particularly useful in laboratories which analyze large blocks of material over several weeks. We have employed the system for wheat nursery materials and for the screening of the USDA World Wheat Collection.~~ In addition to the time saved in running a large number of moisture determinations, it is possible to weigh to a definite moisture basis and eliminate the need to convert data to a moisture level following the analytical determination.

In addition to wheat and wheat flour, 10 different grains were tested in the cabinet. We also are all were being subjected to adsorption effects, although we do not have individual adsorption and desorption isotherms for all samples. The samples had been [illegible] to pass a 1.0-mm. screen (0.040 in.) with the new Udy cyclone grinder. All

17. ~~[illegible]~~

The samples came to their individual moisture levels between 8.75 and 12.10% moisture within 4 days (Table I). Moisture levels were maintained constant for 135 days. Most of the grain samples equilibrated from 11.30 to 12.00% moisture. The soybean sample had a fat content of 21.4%, which contributed to the low moisture of 8.7%.

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A Cabinet With Controlled Humidity to Bring Cereal Samples to Constant Moisture[1]

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LABORATORIES ENGAGED IN the analyses of cereal products often spend large amounts of time for the determination of moisture. If analyses need not be determined immediately, a moisture equilibration cabinet can be used to bring samples to a uniform moisture content. This arrangement is particularly useful in laboratories which analyze large blocks of material over several weeks. We have employed the system for wheat nursery materials and for the screening of the USDA World Wheat Collection.

In addition to the time saved in running a large number of moisture determinations, it is possible to weigh to a definite moisture basis and eliminate the need to convert data to a moisture level following the analytical determination.

Materials and Methods

Cabinet, Shelving Units, and Humidifier. Model #505-SS Bailey Fermentation Cabinet and the shelving units are supplied from National Manufacturing Company, 1218 North 22nd Street, Lincoln, Nebr. 68503. National also supplies a humidifier unit identical or similar to Walton Montclair Model WF-225 from Walton Laboratories, Inc., 1835 Burnett Avenue, Union, N.J. 07083.

The cabinet may be purchased with only the squirrel cage circulating fan system. The humidity controls normally supplied are inadequate for equilibration control and temperature controls are not needed if room temperature control is satisfactory.

The following humidity controls which we have used are available from Hygrodynamics, Inc., 949 Selim Road, Silver Spring, Md. 20910:

1) Electronic hygrometer controller, Model 15-3216
2) Wall mounting unit, No. 15-6100 (for sensor)
3) Humidity sensor, No. 4-4819 (color code green)
4) Sensor cable, No. 88-301-37 for use from the wall mounting unit to the hygrometer controller box (normally 6 feet should be sufficient)

Teflon adhesive tape: Produced by Dodge Industries, Hoosick Falls, N.Y. 12090 and distributed by McMaster-Carr, P.O. Box 4355, Chicago, Ill. 60680.

Clear plastic sample boxes: No. 415, 2 in. × 2 in. × 3/4 in. with lids supplied by Bradley Industries, 11040 West King Street, Franklin Park, Ill. 60131.

Moisture method 44-16 (1) was used to monitor control samples in the humidity cabinet.

Past Research on Moisture Equilibration of Cereals with Various Levels of Water Vapor

Hlynka and Robinson (2) have reviewed the problems relating to moisture content in cereals and included a good bibliography.

To understand the operation of an equilibrating cabinet for cereals, one must know the relationship of moisture contents in grain with known levels of relative humidity. At a given temperature this relationship is given by an isotherm. This isotherm describes the equilibrium relationship of the amount of water adsorbed on a sample at some level of relative humidity. Depending on whether water is adsorbed or desorbed to reach an equilibrium determines whether the isotherms are known as adsorption or desorption isotherms, respectively.

Babbitt (3) clearly differentiated between adsorption and desorption equilibria. His isotherms for wheat and flour previously redrawn (2) and reproduced in Fig. 1 show the difference in final moisture content which will result from samples being subjected to adsorption or desorption conditions.

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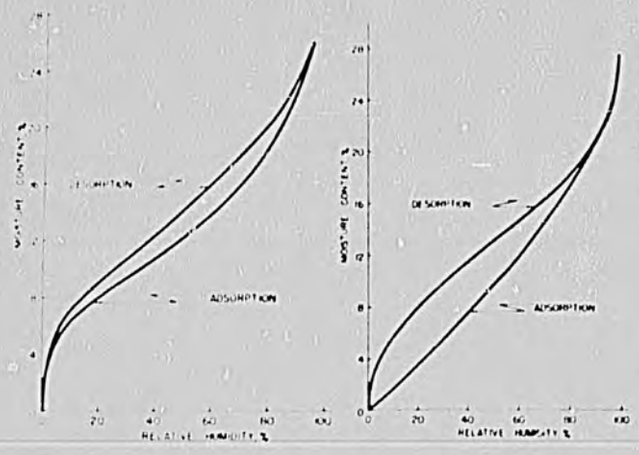

Fig. 1. Isotherms at 25 C. for flour (left) and wheat (right). From: Reference 2, Fig. 1, p. 6

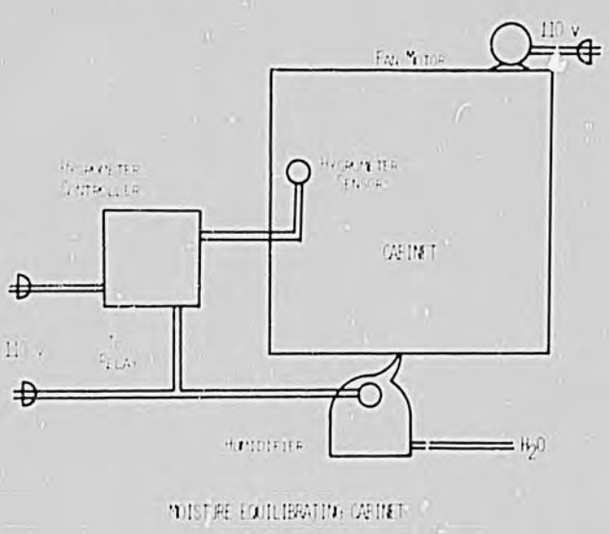

Fig. 2. Schematic diagram for the humidity cabinet.

The moisture adsorption and desorption phenomena in cereals closely parallel that reported for starches (4). This is logical because starch is the largest component in cereals.

Moisture values for proteins are also similar. Calculations for moisture from adsorption and desorption isotherms for casein (5) at 45% r.h. are 8.6 and 11.1%, respectively.

Setting up the Moisture Equilibrating Unit

One has a wide choice in the type of cabinet which can be used.

A fermentation type cabinet with a number of access doors is particularly well adapted for use as a moisture equilibrating cabinet. The need for temperature control is eliminated if existing room controls are adequate. Air circulation is usually already provided. Therefore, humidity control is the main concern. The humidifier unit was placed under the cabinet (Fig. 2) and the moisture output was transported through the bottom of the cabinet with 0.25-in. I.D. rubber pressure hose. This small opening was essential to prevent overshooting the humidity in the cabinet during cycling of the humidity controller unit.

Our cabinet was set up to increase moisture content of samples through absorption of water vapor.

The relative humidity in the room is always maintained below that of the cabinet by an automatic dehumidifier. Under our normal building conditions, the dehumidifier is required about two months of the year.

The hygrometer controller unit and sensor are installed according to the schematic given in Fig. 2. A calibrated setting on the controller unit is used to maintain a relative humidity (r.h.) of approximately 45% in the cabinet. With this r.h. and a room temperature of 21° to 22°C, one can maintain a ground wheat sample at an 11.7 to 12.0% moisture content.

The moisture equilibrating cabinet is supplied with 12 small doors (Fig. 3). Normally we place 9 or 10 shelf units in the unit. Each shelf unit (Fig. 4) contains 9 trays, each tray holds 45 plastic sample boxes 2 in. × 2 in. × 3/4 in. or 405 samples per door or 4,050 samples per cabinet. Individual trays being used are placed in a single door section to permit easy access and to prevent possible spilling of samples (Fig. 3).

We routinely place self-adhesive Teflon on the runner edges of the shelf in order to minimize friction and keep powdered metal from falling into the samples.

Depending on the original moisture content of the wheat when placed in the cabinet, constant moistures are obtained in 3 to 5 days for fine ground material and 21 days for whole kernels of wheat.

The effect of adsorption and desorption in the constant humidity cabinet on hard red winter wheat flour is shown

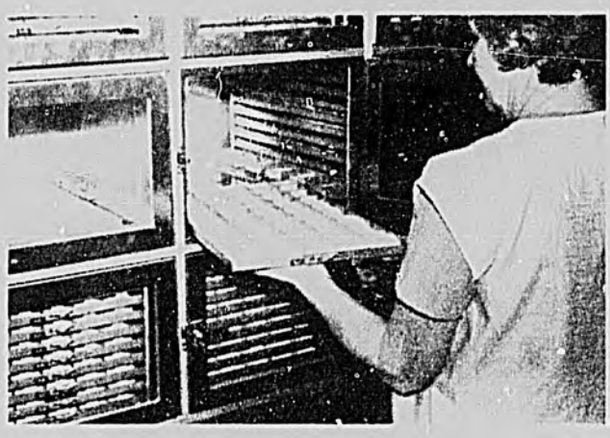

Fig. 3. Moisture equilibrating cabinet.

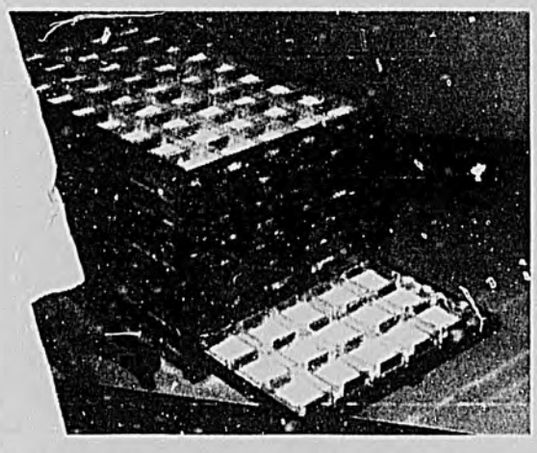

Fig. 4. Stainless-steel shelf unit for moisture equilibrating cabinet.

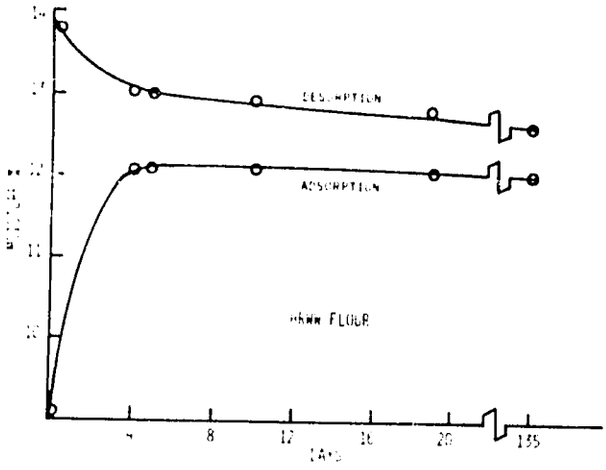

Fig. 5. Adsorption and desorption curves for a HRWW flour at 45% r.h. and 25°C.

in Fig. 5. Three replicates of two samples of the same flour were placed in the cabinet at approximately 9% and 14% moisture. After 4 days, the moisture contents were 12.10 and 13.05%, respectively. Agreeing with the isotherms shown in Fig. 1, the moisture differential continued to be maintained for the 135-day test.

To equilibrate the cabinet properly, samples and controls must be on the sorption cycle. This is achieved if samples are placed in the cabinet below the normal equilibrating moisture of 11.75%. Normally, this is no problem because our laboratory conditions produce moisture levels of less than 11% in samples of wheat and flour.

In addition to wheat and wheat flour, 10 different grains were tested in the cabinet. We assume all were being subjected to adsorption effects, although we do not have individual adsorption and desorption isotherms for all samples. The samples had been ground to pass a 1.0-mm. screen (0.040 in.) with the new Udy cyclone grinder. All samples came to their individual moisture levels between 8.75% and 12.10% moisture within 4 days (Table I). Moisture levels were maintained constant for 135 days. Most of the grain samples equilibrated from 11.30 to 12.00% moisture. The soybean sample had a fat content of 21.4%, which contributed to the low moisture of 8.7%. These are reasonable moisture levels to ensure safe storage against microorganisms. If insect infestation becomes a problem on samples being held for abnormal lengths of time, an individual shelf section of 9 trays can be fumigated outside the cabinet in a suitable sealed container.

TABLE I. MOISTURE VALUES ON VARIOUS SAMPLES AFTER ADSORPTION

Sample	Number of Days 0	4	10	135
Hard wheat flour	9.15	12.10	12.10	12.05
Hard wheat	10.80	12.00	11.95	12.00
Soft wheat flour	8.65	11.90	11.80	11.75
Soft wheat	10.40	11.65	11.65	11.65
Triticale	9.05	11.30	11.30	11.20
Rye	9.15	11.50	11.45	11.40
Rice	10.20	12.05	12.05	11.95
Barley	9.10	11.50	11.40	11.40
Oats	8.35	10.85	10.80	10.65
Corn, yellow	8.95	11.45	11.30	11.08
Millet	9.60	11.45	11.45	11.05
Sorghum	9.35	11.55	11.60	11.55
Field beans	8.65	11.15	11.15	11.10
Soybeans	6.75	8.75	8.70	8.40

TABLE II. MOISTURE CORRECTION TO WEIGH TO DRY WEIGHT BASIS

Moisture %	Dry Weigh for 1.0 g	Dry Weigh for 0.5 g
11.50	1.1299	0.5650
11.52	1.1302	0.5651
11.54	1.1305	0.5653
11.56	1.1307	0.5654
11.58	1.1310	0.5655
11.60	1.1312	0.5656
11.62	1.1315	0.5658
11.64	1.1317	0.5659
11.66	1.1320	0.5660
11.68	1.1322	0.5661
11.70	1.1325	0.5663
11.72	1.1328	0.5664
11.74	1.1330	0.5665
11.76	1.1333	0.5667
11.78	1.1335	0.5668
11.80	1.1338	0.5669
11.82	1.1340	0.5670
11.84	1.1343	0.5672
11.86	1.1346	0.5673
11.88	1.1348	0.5674

Sample Weighing Procedures

Several control samples are weighed each morning for moisture to check on the operation of the cabinet. Weighing tables for various sample weights have been prepared to obtain weights on a 0% and 14% moisture basis. Using this technique it is unnecessary to convert analytical data after analysis. For example, with Table II one would weigh 1.299 g. of an 11.50% moisture sample to obtain a 1-g. sample on a dry weight basis. In addition to saving time, it eliminates possible errors in recalculating analytical data. Samples also can be held until data are completed, and rechecks can be made if necessary with minimum effort.

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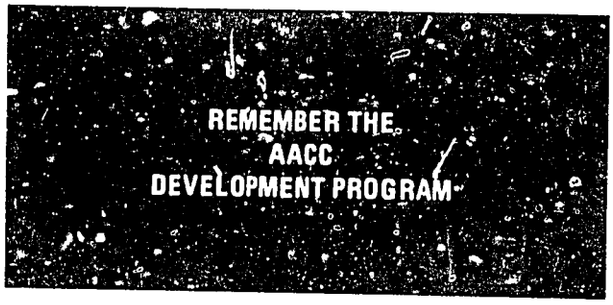
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