A SEMI-AUTOMATIC APPARATUS FOR DETERMINING MOISTURE IN CEREAL PRODUCTS

By

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The moisture content is an important determination in the analysis of cereal products. In addition to its influence on the storage quality, the moisture content also has an indirect effect on the proportion of other constituents. The moisture content of flour and of semolina is a clue to the adequacy of the tempering and milling of the original wheat.

As the moisture content increases the apparent concentration of the dry matter containing the remaining constituents will decrease, since the analyst is weighing a larger proportion of water in the sample. For example, the protein content of a sample of flour containing 13.0% of moisture might be 12.0%, but at 8.0% the protein content of the same flour would be 12.7%, since there is more flour present at the lower moisture level. Similarly, on the "dry basis" the protein content would be 13.8%. These examples illustrate the influence of moisture content on the apparent protein percentage.

The moisture content of flour and other cereal products may easily vary from 8.0 to 14.0% depending on the conditions to which the example has been exposed. Moisture is very rapidly lost from flour, semolina, etc. under conditions occurring in laboratories in North Dakota during the winter months, when the relative humidity is low. It is advisable to compute analytical data to a uniform moisture level, thus removing the effect of differences in moisture content. This department uses a 13.5% moisture basis for wheat, flour and semolina, but calculates barley meal results on a moisture-free or dry basis so that our data can be directly compared with that of other barley testing laboratories, who employ this basis.

Methods of Determining Moisture in Cereal Products

Methods available for the determination of moisture in cereal products include: (1) heating in a vacuum oven at 98-100° C. for five to six hours; (2) heating in an electric drying oven without vacuum for one hour at 130° C; and (3) the Brabender semi-automatic combination drying oven and weighing balance. In a variation of the electric oven procedure, which is found in some mill laboratories, the moisture dishes rest on an aluminum plate during the heating period which is 15 minutes at 140° C., and are cooled for approximately 2½ minutes on a second aluminum plate before weighing. These methods depend upon measurement of loss in weight (moisture) during heating. Another method can be used for cereals which involves measuring the electrical capacitance of the cereal, since the capacitance changes with moisture content.

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This department has employed the one-hour electric oven method for ascertaining the moisture content of flour and semolina, while for barley meal the moisture content of the barley prior to grinding in a hammer mill was used for correcting barley quality data to a uniform moisture basis. This procedure assumes that no moisture loss occurs during grinding; for low moisture barley this assumption appears to be justified, but with barley at 12.0% or higher moisture loss will occur. Moisture determinations by the standard oven method are slow and time-consuming when a large number of samples are to be tested. For this reason we have not determined the moisture content of flour and semolina samples for micro-baking and processing. It appeared that the Brabender semi-automatic moisture tester might be the answer to the problem, and one was secured. Following is a description of this apparatus, and results obtained with it in this laboratory.

Brabender Semi-Automatic Moisture Tester

The semi-automatic moisture tester manufactured by the Brabender Corporation, Rochelle Park, New Jersey, consists of an electric drying oven with a sensitive balance attached in an enclosed cabinet. This balance is so constructed that it will weigh the dried sample and container in the oven itself without the necessity of removing the sample from the oven and cooling, thus no dessicators are needed and no handling of the dishes is required. It is probable that at least 50% more samples can be tested in a given time with this apparatus as compared with the alternative drying oven method. The electronic method which measures the electric capacitance of the material to determine the moisture content is more rapid, but both the accuracy and replicability of this method were found to be very poor in some experiments made with the object of discovering whether it would be satisfactory for determining the moisture content of flour and semolina produced in this laboratory. Several other more or less minor faults were found in the operation of the equipment so it was thought best not to make the purchase although it did possess the advantage of being extremely rapid.

Figure 1 is an illustration of the semi-automatic oven tester, with the accessory balance for weighing the sample before drying shown at lower right. The drying compartment is enclosed in the circular insulated chamber which comprises the upper portion of the apparatus and which accommodates 10 samples at one time. Hot air is circulated vigorously through the compartment by a small motor and fan located at right rear with air inlet leading to right front of the drying space. At the top of the chamber is the thermometer and temperature control switch which accurately controls the drying temperature. A glass door in the front of the chamber affords access to the interior and allows visual inspection of the sample at any time during the drying operation. The lower portion of the oven contains a sensitive balance for weighing the sample after drying. Results are read directly in percent moisture on a

small illuminated dial at right of balance case. The tester has a working range of 0.1% to 100% moisture.

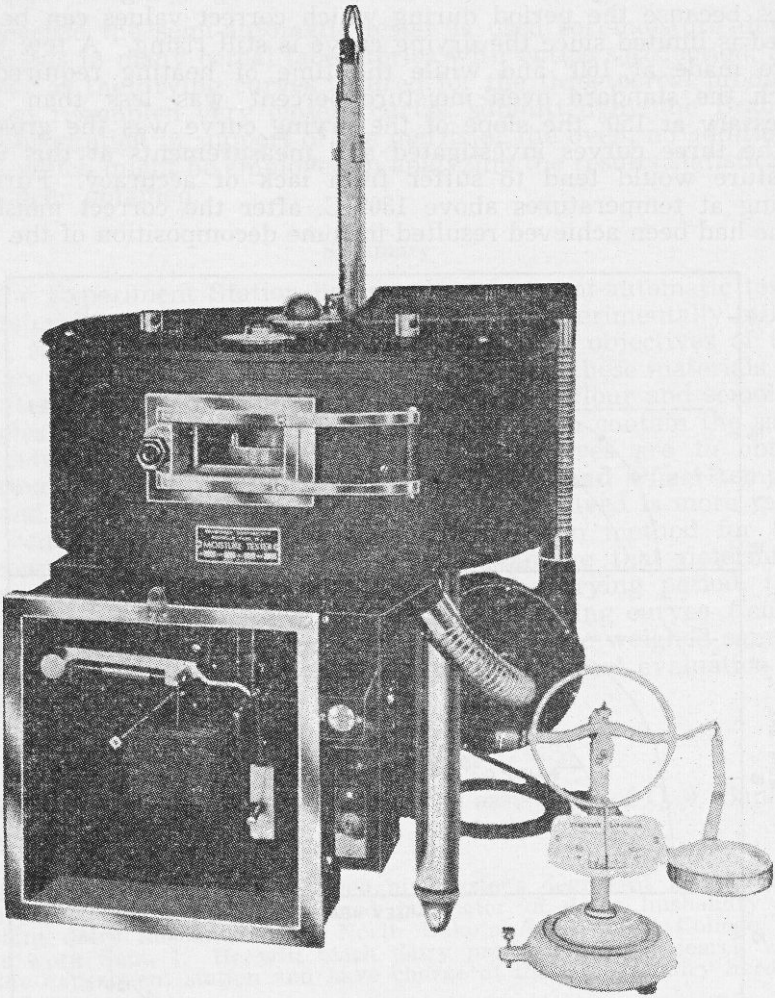

Figure 1. The Brabender semi-automatic tester for the determination of moisture content recently secured by the North Dakota Experiment Station for ascertaining the moisture content of cereal products.

Preliminary Results with the Tester

Figure 2 provides comparisons between the standard electric drying oven procedure and the semi-automatic tester. These comparisons made with the three materials in which this department is most interested show that for wheat flour and barley meal moisture assays can be completed in 45 minutes with the tester at 130° C. but with semolina approximately 60 minutes are required. By raising the drying temperature to 150° C. dependable results can

be obtained after 20 minutes for flour and semolina and after 13 minutes for barley meal. However, there is a strong probability that less accuracy will be secured in working at higher temperatures because the period during which correct values can be secured is limited since the drying curve is still rising. A few tests were made at 160° and while the time of heating required to reach the standard oven moisture percent was less than that necessary at 150° the slope of the drying curve was the greatest of the three curves investigated and measurements at this temperature would tend to suffer from lack of accuracy. Further drying at temperatures above 130° C. after the correct moisture value had been achieved resulted in some decomposition of the ma-

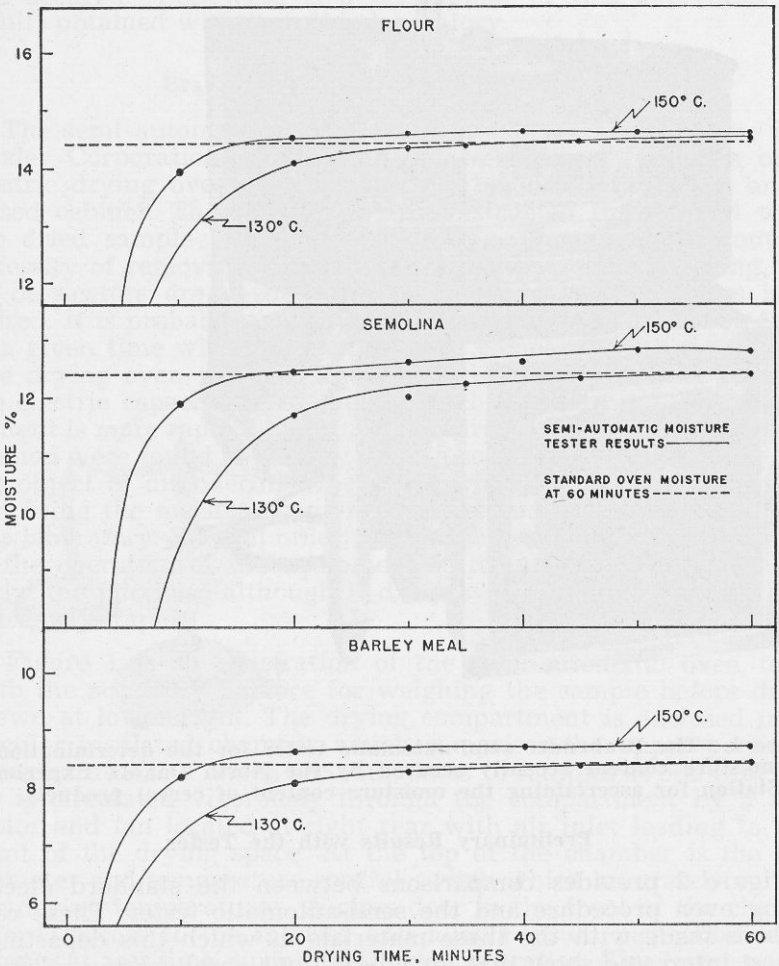

Figure 2. Representative rate of drying curves secured at 130° and 150° C. with the Brabender semi-automatic oven from flour, semolina and barley meal. Comparisons with the standard electric oven method are also shown.

terial for all the three cereal products, as shown by increased loss of weight, which would yield misleading information regarding the true moisture content.

Because the semi-automatic tester is used for moisture determinations in many cereal laboratories with entire satisfaction, and further as the drying curves secured for the three cereal products studied resembled very closely curves submitted by the Brabender Corporation in support of the merits of the oven, no additional data which might be employed in analyzing the results statistically have been obtained.

Summary

The Experiment Station has purchased a semi-automatic tester for determination of the moisture content of experimentally milled flour, semolina and barley meal. The primary objectives of this test are to insure that important constituents of these materials are reported on a uniform moisture basis, and that flour and semolina samples used for bread and macaroni production contain the same proportions of dry matter. Secondary objectives are to obtain information regarding safe storage conditions, and wheat tempering and milling efficiency. The procedure involved is more rapid and convenient than the standard drying oven method for this purpose and possesses the additional advantage that determinations may be made at any time during the drying period, thus making possible the construction of rate of drying curves (length of drying period, vs. moisture percent) from one weighed sample. It should tend to improve the quality of the cereal evaluation investigations.

Acknowledgment

The authors wish to acknowledge the assistance of O. J. Banasik in preparing Figure 2.

Edward J. Stone, who received his master's degree at Rutgers University last June, has been named instructor of dairy husbandry and assistant dairy husbandman at North Dakota Agricultural College. He starts work Sept. 1. He will teach dairy production, do research work for the experiment station and have charge of the college dairy herd.

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A recent issue of the Journal of Wildlife Management discusses safflower as a winter food for pheasants and Hungarian partridge. Both of these game birds adapted themselves to it readily during the winter, in Idaho, when most food was covered by snow. In fact the birds preferred safflower to corn, reports Prof. O. A. Stevens, NDAC botanist.

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The July issue of American Journal of Veterinary Research contains a paper, "Experimental Avitaminosis in Sheep," by D. F. Eveleth, D. W. Bolin and Alice I. Goldsby of the NDAC veterinary staff.