An Investigation of Oven Methods for Determining the Moisture Content of Shelled Peanuts

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Air-oven methods, using ground, sliced, and whole shelled peanuts, were investigated. The use of ground samples was found to be unsatisfactory. Slightly more accurate results were obtained with whole nuts than with sliced nuts. The method of heating 50-g. samples of whole shelled peanuts for 3 hrs. at 130°C in a forced-draft oven gave results agreeing closely with those obtained by the Karl Fischer method for samples of low moisture content.

The accurate analysis of peanuts is important, not only for purposes of grading but also in estimating the value of the products obtained when the peanuts are processed. Correct moisture determinations are essential to the analysis. If electronic moisture meters are used, the accuracy of these devices is limited by the accuracy of the oven or chemical method against which they are calibrated.

A variety of oven methods are used, or have been proposed, for the determination of the moisture content of shelled peanuts. Fifty g. of whole kernels are heated for 3 hrs. at 130°C. (7) or for 5 hrs. at 130°C. (4) in a forced-draft oven. Samples are ground in a food chopper, and 5-g. portions are heated for 5 hrs. at 130°C. in a forced-draft oven (4) ; or 5 to 10 g. of the ground material are heated for 5 hrs. at 101°C. in the forced-draft oven (1). In another method the kernels are ground to a paste, and 2 g. of the paste are heated to constant weight (5 hrs.) in a vacuum oven at 95–100°C. (6). Sliced nuts are heated for 3 hrs. at 130°C. or for 16 hrs. at 105°C. in a forced-draft oven (9). It would be remarkable if these diverse methods gave comparable or equally satisfactory results.

Oven methods are empirical. The establishment of a method requires that a decision be made as to the time and temperature of heating. Drying is usually considered complete when the samples reach constant weight. Time and temperature for some procedures are selected by comparing results with another method, which may itself be empirical.

The purpose of this investigation is to find which of the methods, using a forced-draft oven, gives results in best agreement with those of a standard method. Oven methods were studied for whole, sliced, and ground peanuts. Some of the factors which tend to produce errors were also investigated.

The Karl Fischer method, as it has been applied by Hart and Neustadt (2,3) to the determination of moisture in seeds, is used as the standard. This method has been found satisfactory in determining the moisture content of such oil-bearing seeds as soybeans, flaxseed, sunflower seed, and safflower seed. The water is extracted from the seed without the use of high temperatures. It has been shown that the extraction is complete and that the Karl Fischer reagent determines the water in the extract accurately. All determinations by the Karl Fischer method were made in quintuplicate.

Experimental

Samples. Forty-seven samples of peanuts, divided about equally among the three types, Virginia, Spanish, and runner, and ranging from 4.75 to 14.44% moisture content were held in sealed mason jars at 40°C. A wad of cotton, to which a few drops of formaldehyde had been added, was placed in the top of each jar to prevent mold in high-moisture samples. Before being tested, each sample was put through a Boerner divider three times.

Choice of Oven Method for Whole Kernels

Time and Temperature of Drying. The Brabender oven was used to find the correct drying-time for a given temperature. In this oven it is possible to weigh the samples without removing them from the oven. Thus a graph may be made of time vs. weight loss. Ten of the 47 samples were used and three temperatures, 120°, 125°, and 130°C. were tried. In Figure 1 the heating time is plotted against the average apparent moisture content for the 10 samples at the three temperatures. The graphs indicate that, at 120°C., 8 hrs. would be required to cause a weight loss equal to the average moisture content obtained by the Karl Fischer method. At 125°C., 4½ hrs. would be required, and at 130°C., 3 hrs. Three hrs. at 130°C. were chosen to avoid an excessively long heating-period.

Determination of Sample. Duplicate moisture determinations were made on 22 samples (3 hrs. at 130°C.), using 10-, 25-, 50-, 75-, and 100-g. samples.
The 10-g. portions were placed in grain moisture boxes 2 in. in diameter and 5/8 in. deep. All other weights were dried in grain-can lids, 5 1/2 in. in diameter and 5/8 in. deep. In all cases the kernels were spread in a single layer. Each 100-g. portion required two can lids. Figure 2 shows the weight of the samples plotted against the average difference between duplicate determinations. The minimum difference between duplicate determinations is attained with portions weighing 75 g. or above. No great loss of accuracy occurs in using 50-g. portions.

Oven Method for Sliced Peanuts

The advantage of slicing or grinding, from the standpoint of accuracy, is that a large sample of sliced material may be thoroughly mixed and a small uniform portion taken for analysis. A Henry nut slicer was used. In this mill rotating fins push the nuts against a razor blade projecting through a slit in the cylindrical wall. The thickness of the slices is determined by adjusting the distance the blade extends into the cylinder. There is however no scale or other means of precise adjustment that would assure uniform thickness when the mill is reassembled after cleaning.

Ten samples of sliced nuts were heated in the Brabender oven at 130°C. The weight loss at the end of 3 hrs. coincided with the average of the values obtained by the Karl Fischer method for these samples (Figure 3).

There was very little loss in weight in the period between 1 hr. and 7 hrs. The sliced nuts became continuously browner during the heating-period. This suggested that some factor was causing gain in weight and compensating for the normal loss in weight due to browning. One cause for gain in weight in a substance with a high oil content is oxidation of the oil. This was investigated. Oil was pressed from two portions of a sample of sliced peanuts. One portion had not been heated, and the other had been heated in the forced-draft oven for 3 hrs. at 130°C. The peroxide value of each oil was determined by the A.O.C.S. method. The oil from the unheated peanuts had a peroxide value of 0.4, and that from the heated peanuts was 82.4. In five other samples in which the slices were thicker, the values for the unheated peanuts were 0.2, 0.2, 0.6, 0.8, and 0.4, and those of corresponding heated portions were 14.4, 22.6, 19.2, 11.6, and 17.8.

Moisture determinations were made on sliced nuts from 22 samples. About 100 g. of peanuts from each sample were sliced, then thoroughly mixed by stirring with a spatula. Portions of this material (about 3 g.) were weighed, placed in grain moisture boxes, and heated 3 hrs. at 130°C, in the forced-draft oven. The average loss in weight for the 22 samples was 6.36%. The average moisture content for the same samples, as determined by the Karl Fischer method, was 6.28%. The average differences between oven-determined moisture contents and Karl Fischer determinations was 0.072%; the standard deviation of these differences was 0.521%. When determinations were made on the same samples by the method of heating 50 g. of whole kernels at 130°C, for 3 hrs., the average difference between the moisture content and the corresponding Karl Fischer value was 0.14%, and the standard deviation of these differences was 0.16%.

That variations in the setting of the blade in the mill may be the cause of error is illustrated by the results obtained in the following experiment.

Peanuts from the same sample were sliced at four different settings of the mill, which gave progressively thinner slices. Moisture determinations were made on the portions obtained from each setting. The results for the respective settings were 9.04, 8.92, 8.84, and 8.79%. The greatest difference between duplicate determinations was 0.07%.

There is another source of error which tends to make this method unsatisfactory. Oil and gummy materials exude from the peanuts when heated and harden on the moisture boxes so that they cannot be removed except by thorough washing with detergent. Consequently, unless the boxes are tared after each use, error is introduced. It was found that after one use the average increase in tare weight for 26 moisture boxes was 0.0015 g. If the original tare weight had been used in the next determination, the error would have amounted to 0.05%.

![Figure 2](image2.png)

**Figure 2.** Relationship between weight samples of peanuts and agreement between duplicate determinations.

![Figure 3](image3.png)

**Figure 3.** Change in apparent moisture content of sliced peanuts at 130°C, with increase in time of heating.