RAPID MEASUREMENT OF THE MOISTURE CONTENT OF LARGE SEEDS

F. T. Bonner and B. J. Turner
Principal Plant Physiologist and Biological Laboratory Technician, USDA Forest Service, Southern Forest Experiment Station, Starkville, Miss.

Most nurserymen and others who deal with tree seeds use electric moisture meters for rapid measurement of the moisture content of seeds. But these meters can be used only for small seeds because large seeds, such as hickory nuts or acorns, will not fit in the measurement chambers. Also, the moisture content of acorns is above the measurement range of such meters. Laboratory methods for determination of the moisture in large seeds require overnight drying in ovens or elaborate equipment (*2*).

We have found that seed moisture can be removed from large seeds in 5 minutes or less by drying them in an ordinary microwave oven and approximate moisture content can be determined gravimetrically in about 6 minutes.

Experimental Methods

The microwave oven used in this study was a General Electric JET 85, OT 1. It has a "high" and a "low" energy range, and the timer can be set at 30-second intervals for up to 25 minutes.

Seeds of the following species were studied: Shumard oak (*Quercus shumardii*), water oak (*Q. nigra*), shagbark hickory (*Carya ovata*), green ash *(Fraxinus pennsylvanica), and* white ash (F. americana). The two ashes were included in the test because their winged seeds (intact samaras) do not fit well in the chambers of electric meters.

Sample sizes were 3 g for both ash species. Samples of acorns and nuts were equal to the fresh weight of 5 sound seeds. Acorns and nuts were cut or cracked into pieces because intact seeds would explode in the oven when drying. Empty or rotten acorns and nuts were discarded.

Drying was in uncovered glass dishes or beakers. Preliminary trials suggested that the low range was best, so it was used in all tests. Drying times indicated by preliminary tests were:

Shumard and water oaks—
4½ minutes
shagbark hickory—
4½ minutes
green and white ashes—
5 minutes

Samples were weighed to three decimal places on an electronic pan balance. All weight loss was assumed to be water, and moisture percentages were calculated on a fresh weight basis.

The preliminary trials showed that the temperature in the oven at the start of drying greatly influenced sample drying over a set time. To standardize the procedure, we turned the oven on for up to 10 minutes with only a dish of water inside. When the temperature of the center of the oven floor reached 60° C, a sample was placed inside for drying (always on the center of the floor). All drying was begun when floor temperature was 60° C. Oven temperature was measured with a mercury bulb thermometer on the floor.

Duplicate samples were used, with one measured in the microwave oven and the other in a forced-draft oven by standard measurement procedures. Shumard oak and shagbark hickory samples were checked by the toluene distillation method. Mean values from 20 to 30 lots of each species were compared—microwave oven versus standard oven—by a chi-square test (*1,3*). The goal was to have microwave values within 2 percent of the values as determined by standard methods for shagbark hickory and the ashes and within 5 percent for the oaks at the 0.05 probability level.

Results and Discussions

Measurements of oak seeds varied widely (table 1). The chi-square equation indicated error limits of 7.2 percent for Shumard and 6.6 percent for water oak. These values mean that microwave oven measurements will be within 7.2 or 6.6 percent of the true moisture contents unless a 1-in-20 chance has occurred.

Measurements of the other three species, which have lower moisture contents, were much more successful (table 1). All mean differences were less than 1.0 percent, and the greatest range was 0 to 3.1 percent.

Potential users of the microwave oven method should keep in mind

Table 1.—*Performance of the microwave oven method compared with the standard method*

Species	No. of lots	Sample size	Difference between methods		Error limit
			Range	Mean	
		G	- - - - *Percent* - - - -		
Shumard oak	30	25	0-9.6	3.5	7.2
Water oak	20	10	0.3-7.6	3.8	6.6
Shagbark hickory	21	20	0.2-3.0	0.9	1.7
Green ash	20	3	0-3.1	.9	1.9
White ash	20	3	0.2-2.3	.8	1.8

the amount of error that exists in this procedure. Also, the drying times used in our tests may not work with other ovens, and each oven should be tested. However, if rapid determinations of the moisture content of large seeds are needed, the microwave oven method is the only one available.

We suggest these procedures:

(1) Use a sample of 3 to 5 g for small seeds or about 10 large seeds or fruits (acorns, nuts, etc.).

(2) Break large seeds into fragments no larger than one-quarter of intact seed size and place mixed pieces in a tared glass container. Use samples equal to the fresh weight of 5 intact seeds. Acorns can be cut into pieces with small pruning shears.

(3) Record fresh weight to three decimal places.

(4) Preheat the oven with a dish of water on the center of the oven floor.

(5) Monitor temperature at this spot with a thermometer. When the temperature reaches 60° C, place the container and sample on this center spot.

(6) Turn on the oven for the selected period. While the first sample is drying, draw, prepare, and weigh a duplicate sample in the same manner, and be ready to dry it.

(7) When the drying time is ended, remove the sample and immediately weigh it on an electronic pan balance. If such a balance is not available, the samples should be cooled for 30 to 45 minutes in a desiccator before weighing.

(8) Calculate moisture content:

$$\text{Percent moisture} = \frac{\text{seed fresh weight} - \text{seed dry weight}}{\text{seed fresh weight}} \times 100$$

Literature Cited

1. Freese, F. 1960. Testing accuracy. For. Sci. 6: 139-145.
2. International Seed Testing Association 1976. International rules for seed testing. Seed Sci. Tech. 4:3-177.
3. Rennie, J. C. and H. V. Wiant, Jr. 1978. Modification of Freese's chi-square test of accuracy. Resource Inven. Notes BLM 14. USDI, Bur. Land Man. 3 p.