WAYS TO TEST SEEDS FOR MOISTURE

Ways To Test Seeds For Moisture

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The moisture in a seed has a strong bearing on the length of time it remains viable. Seeds may sprout or molds may develop at high levels of moisture, and the seeds may lose viability in a few days.

At the ordinary temperatures, if the relative humidity of the air around the seeds is more than 75 percent, the seeds are likely to support the growth of molds to the extent that they should not be stored even for a short time.

The moisture content of seeds in equilibrium with this critical relative humidity varies among different kinds. For the various cereal grains, an atmospheric relative humidity of 75 percent corresponds to moisture contents in the range of 13.5 to 15 percent. Seeds high in oil usually have a lower moisture content at this humidity.

Moisture levels below those that cause actual sprouting or mold development may still be high enough to support fairly active physiological activity within the living seeds. Such activity will result in premature weakening and loss of viability.

Within certain limits, the lower the moisture content of any kind of seed, the greater the time it will maintain viability. The optimum moisture level for the storage of many kinds appears to be between 6 and 8 percent. Excessively low moisture may cause injury to the embryo. Complete dehydration no doubt would destroy the life of the embryo. Unless artificial drying with heat is employed, however, excessive dryness in seeds is rarely a practical problem.
The basic methods for determining moisture in seeds are those by which a weighed sample is heated in an oven at a specified temperature for a specified time or until they attain constant weight. The loss in weight as a result of heating is taken to be equivalent to the moisture content of the original material. Various types of ovens are used, and various temperatures and times of heating are specified.

Actually, in biological materials it probably is not possible to drive off all moisture by heating without at the same time losing at least traces of other volatile substances or else producing weight changes in some of the constituents of the material as a result of oxidation or decomposition. It is difficult by any known method therefore to determine precisely the true moisture content of any sample of seed.

Because different "basic" methods may yield somewhat different results, for comparative purposes it is desirable to make all tests of a given kind of seed by the same method.

Air-oven methods are used commonly for moisture determinations. The air ovens are electrically heated. The air within them is at atmospheric pressure and is circulated by convection or mechanical means. A temperature of 130°C. and a heating time of 1 hour are specified for most kinds of seeds.

The loss of weight that occurs during drying, calculated on a percentage basis, is taken to be the percentage of moisture in the seed before drying.

Large seeds, such as cereal grains, beans, and peas, must be ground before one determines moisture by this method in order to provide rapid enough penetration of heat and ready escape of moisture. Small seeds, such as those of the grasses, do not require grinding.

When this method is applied to large seeds that are too wet to be ground easily without losing moisture in the grinding process, a two-stage procedure is used. A weighed portion of the seeds is partly dried by exposing it to the air in a warm place. The loss of weight in this preliminary drying is determined. The partly dried sample is then ground, and the moisture content of it is determined in the usual manner. The moisture lost in both stages of the procedure must be considered in calculating the moisture content of the original seeds.

Seeds of a high oil content usually should not be ground for oven moisture determinations because they are difficult to grind properly and because oxidation of the oil during drying may result in a gain in weight of the oil. Errors therefore may be made in the determination of moisture. Oxidation of oil is a particularly serious consideration in seeds, such as those of flax that contain oils of high iodine number ("drying" oils).

Certain seeds contain constituents other than moisture that are volatile at 130°C. and hence cannot be subjected to that temperature in the determination of moisture without introducing errors in the determination.

The rules of the International Seed Testing Association specify that for such seeds a drying temperature of 105°C. be used and that the drying time be 16 hours. The following seeds are in this classification: Shallot (Allium ascalonicum), onion (Allium cepa), leek (Allium porrum), garlic (Allium sativum), carob (Ceratonia siliqua), soybean (Glycine max), and radish (Raphanus sativus).

The seeds of Abies (fir) and Picea (spruce) contain constituents of such high volatility that oven methods are not recommended. The toluene distillation method is recommended.

Air-oven methods are specified as the basic methods for determining moisture under the Official Grain Standards of the United States and the United States Standards for rice, beans, peas, and lentils. A 130°C, 1-hour, air-oven method is specified for wheat, barley, oats, rye, grain sorghums, soybeans, rice, peas, and lentils. The method provides for grinding the
WAYS TO TEST SEEDS FOR MOISTURE

seed before drying. A 103° C, 72-hour air-oven method is specified for corn and beans and a 103° C, 4-hour, air-oven method is specified for flax seed. These methods for corn, beans, and flax do not require grinding of the seed.

Special types of air ovens have a built-in balance for weighing the dried samples while they are still in the oven. The balances are calibrated directly in terms of percentage of moisture so that no calculation is required when the designated weight of sample is used initially.

A vacuum-oven method is one of the official methods of the Association of Official Agricultural Chemists for determining moisture in the cereal grains. A weighed portion of the finely ground grain is heated at 98° to 100° C in an oven in which a partial vacuum is maintained at a pressure equivalent to 25 millimeters of mercury or less. Heating is continued until no appreciable further loss of weight occurs (usually about 5 hours). The moisture content is calculated from the loss of weight as in air-oven methods. The results, applied to cereal grains, are approximately the same as those obtained by the 130° C, 1-hour, air-oven method.

Desiccants—drying agents—are used sometimes to remove moisture from materials and thus to provide a method for determining moisture. The moisture in seeds and other materials may be determined by placing a weighed amount of the finely ground material in a closed container with a relatively large amount of an efficient desiccant.

The desiccant must have a lower vapor tension than the material that is being dried. The moisture in the material will gradually be vaporized and absorbed by the desiccant. Moisture content is determined by the loss in weight of the original material after it finally attains constant weight.

Reducing and maintaining the atmospheric pressure in the container to a low level will greatly reduce the time required to complete the operation, but even when this is done the time required is too great for most practical purposes. In one of the official methods of the Association of Official Agricultural Chemists for determining moisture in grain, however, the finely ground material is held under vacuum in the presence of concentrated sulfuric acid until constant weight is attained.

One advantage of the method is that it does not involve the hazard of possible decomposition of organic material by heat. Seed of high moisture content, however, may decompose as a result of the action of molds and bacteria before the moisture is reduced enough to inhibit the growth of the organisms.

The toluene distillation method is sometimes used. A weighed portion of the finely ground seed is boiled in toluene in an apparatus that condenses the volatilized materials, collects the condensed water in a tube, and returns the condensed toluene to the boiling flask. The boiling is continued as long as any water continues to accumulate in the tube provided for that purpose, and the moisture in the seed is calculated from the volume of water condensed.

This method is one of the official methods of the Association of Official Agricultural Chemists for determining moisture in grain. The method should prove to be reasonably satisfactory for most seeds that can be satisfactorily ground without any appreciable loss or gain in moisture. It has the advantage that no water-insoluble volatile matter can be measured as moisture. Difficulty is sometimes encountered in reading accurately the volume of water distilled, because the separation between the toluene and water may not be sharp.

The Karl Fischer method depends on the reaction of iodine with water in the presence of sulfur dioxide and pyridine to form hydriodic acid and sulfuric acid. It is one of the most accurate methods.

The seed must first be finely ground and the moisture extracted with
methyl alcohol or other water solvent. The method has not been widely used under practical conditions, since it involves rather complicated equipment and intricate technique. Its greatest usefulness in respect to determination of seed moisture seems to be in checking the reliability of oven methods and in providing fundamental data for use in devising oven procedures that will give the greatest possible accuracy in the determination of moisture content.

Data of this type have been obtained for a number of different agricultural and vegetable seeds and are published in Marketing Research Report No. 304, "Oven Methods for Precise Measurement of Moisture Content of Seeds," issued in 1959 by the Agricultural Marketing Service.

Practical methods for determining the moisture of seed are needed under many circumstances where the basic methods take too much time. Practical methods standardized against one or more of the basic methods therefore have been devised. The results generally are likely to be less accurate than those obtained by the basic methods, but they may be good enough for most practical purposes.

Other heating methods sometimes are used to shorten the time required by standard oven methods for determining moisture content. In general, these methods require heating of the material to considerably higher temperatures than those employed in the usual oven methods. Heating may be accomplished by ordinary electric heating coils, by radiation from infrared lamps, or by means of a high-frequency, high-voltage field. When these methods are employed, it is customary to determine in advance the time of heating and the temperature or other adjustment of the equipment required for each type of material to be tested in order to obtain results in reasonably good agreement with those obtained by one or more of the basic methods.

These methods should be quite useful in certain types of practical seed-testing work because the time required to complete a test is usually considerably less than 1 hour (in some instances 10 to 15 minutes), a number of tests may often be made at the same time, the cost of equipment usually is low, and the accuracy may be fairly high if the proper conditions for making the test are accurately determined for each kind of seed to be tested.

The Brown-Duvel distillation method was used for many years in the routine inspection of grain. It is still used when the faster electrical methods cannot be used satisfactorily. A weighed amount of unground grain is heated in oil to a definite temperature. The moisture volatilized is condensed, collected, and measured in a graduated cylinder. The apparatus must be standardized to provide a definite amount of heat in a definite period of time. The method is arbitrary, and the exact procedure to be followed for each kind of grain in order to obtain results equivalent to those obtained by an official basic oven method must be determined.

The Brown-Duvel method should be applicable to most seeds except those that are light and chaffy. Before it can be used, however, it would be necessary to determine the exact procedure for each kind of grain in order to obtain results equivalent to those obtained by an appropriate basic method. The proper procedures have been established for seeds of wheat, corn, oats, rye, grain sorghums, barley, buckwheat, flax, soybeans, emmer, rice, beans, peas, mustard, cotton, and shelled peanuts.

Calcium carbide reacts chemically with water to produce acetylene gas. This reaction has been used for determining the moisture content of various materials by measuring the weight lost, or, in a closed system, the pressure produced by the evolution of acetylene.

A special device with which pressure
WAYS TO TEST SEEDS FOR MOISTURE

is measured is available for making moisture determinations on finely ground materials by use of this principle. This device has been used in testing various kinds of seeds. Theoretically, if the same weight of seed and calcium carbide were used in all tests, the relation between moisture content and pressure developed would be the same for all kinds of seeds. In actual practice, however, no such constant relationship appears to exist, and it is necessary therefore to calibrate the equipment against some basic method for each kind of seed tested.

**Electric** moisture meters, used in routine work, have an advantage in speed over all other methods for determining moisture.

Most of these instruments are based on measurements of either the conductivity or the dielectric properties of the grain, both of which depend primarily on the moisture content and temperature of the seed, but they also are affected to some extent by many other variable factors. Electrical methods therefore cannot be depended on to give reliable results under all circumstances.

The moisture content of most kinds of seeds probably can be determined fairly accurately under most circumstances by means of electric moisture testers, but they have to be calibrated against an accepted basic moisture-testing method. Separate calibrations must be made for each kind of seed. For some kinds it is also necessary to make separate calibrations for individual classes, varieties, or varietal types.

Because of the errors inherent in the electric methods, each calibration should be based on the testing of a large number of samples, covering a wide range in moisture, obtained from as many different points of origin as possible, and preferably representing the crops of at least several years.

It is obvious therefore that a large amount of work is necessary before a reliable calibration can be made for use in testing seeds with any electric moisture tester. Much work has been done in calibrating certain electric moisture meters for use with the various cereal grains, but relatively little has yet been accomplished in this field for most other seeds.

Electric moisture meters have a great advantage in speed over other methods. With most of the instruments, a test may be completed in a minute or less. Disadvantages are the relatively high cost of the equipment; the need for painstaking calibration for each kind of seed; and in some instances failure of the method to give results of a sufficiently high degree of accuracy. Factors other than moisture content affect the electrical properties of seed, and a more thorough understanding of these factors will be required before any appreciable increase in accuracy of electric moisture-testing methods can be expected.

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For further reading: