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Using a Microwave Oven to Determine Moisture in Forages

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Harvesting and storing forage crops at the proper moisture is necessary to minimize forage losses and to maintain maximum nutritional value. But it is difficult to determine the moisture concentration of forage crops prior to ensiling or baling.

Ways to measure moisture

A common way to measure moisture is the hand-squeeze method. You squeeze the forage into a ball for 30 seconds and then guess the moisture level. This method is very deceptive and lacks precision. Another way to determine moisture — drying forage in an oven — is time consuming and impractical.

Three other methods use specific equipment: the Delmhorst (mention of trade names does not imply endorsement) moisture tester, the Koster tester and the microwave oven.

The Delmhorst moisture tester is a convenient hand-held device that estimates moisture as a measure of electrical resistance. It is designed to estimate moisture in the range of 13 to 40 percent. Considerable variation in readings can exist, as moisture percentage in a bale of hay will vary from wafer to wafer. When using a Delmhorst moisture probe, you should use a second, more accurate method to gain experience and a frame of reference in estimating moisture percentage.

The Koster moisture tester is a portable, forced air electric drying unit. You use a small scale that comes with the heater to weigh forage into a mesh-bottom basket. You put the basket into the drying device and dry the forage until stable readings occur, which takes about a half hour. You then take dry matter/moisture readings directly from the scale. This method gives accurate estimates of forage moisture, but you need to be near an electrical outlet to use it. You can take it to the field if a portable generator is available.

A microwave oven dries forage in a minimum amount of time and can provide accurate forage moisture determinations. The following describes how you can use a microwave oven for moisture testing.

Collecting forage samples

As with all forage analyses, obtaining a representative sample is an important, but difficult, step.

Select three to five locations in the field where the windrow is uniformly thick. With a sharp shears, cut 6-inch cross-sections from windrows. If the forage is dry, try not to lose leaves. Chop the forage into pieces 1 to 2 inches long. Mix samples in a clean pail and subsample for drying.

For baled hays, sample with a Penn State bale corer or another appropriate device. Damp hay baled with preservatives results in excess friction and heats the core borer. This dries the sample while it is still in the bale corer and underestimates moisture significantly.

Selecting equipment

You need a microwave oven with a power range of 50 to 1,000 watts and a small scale (postal, kitchen or dietetic) that weighs in grams. Postal scales are less expensive but they measure in ounces. Results with postal scales are less accurate than scales that measure in grams unless you use large samples (1 to 2 pounds).

Determining moisture content

Moisture determination requires weighing a wet forage sample on a scale, drying it in a microwave oven to a constant weight, and calculating the moisture concentration. The following steps illustrate the procedure.

- **Step 1**

Weigh an empty paper dish and record its weight as weight A (Step 4). You may substitute other microwave-safe containers such as a brown paper bag or containers that are porous so water can evaporate. Do not use metal. The weight of the container will not change much during drying, but you must know it.

- **Step 2**

Place a representative sample of forage in the paper dish. The sample should weigh 100 grams or 1 to 2 pounds if using postal scales. Record the weight of the dish plus the forage sample as B (Step 4).

- **Step 3**

Dry the sample gradually in the microwave oven. **Warning: do not leave drying samples unattended**

Place a small glass of water, three-fourths full, in the back corner of the microwave. Keep water level fairly constant during microwave use. Microwave manufacturers say this prevents damage to the oven.

Begin by drying the sample for 3 minutes. If the sample is fresh material (70 to 80 percent moisture), you may start with 5 minutes; if you think the sample has less than 35 percent moisture, start with only 2 minutes. Use the oven's higher heating or power levels for wetter materials. As the forage dries, lower the heat level. Check for dryness after the initial heating and stir the sample again inside the container to retard loss and to dry layers.

Repeat the 3-minute drying time for very wet samples. Check and stir the sample again. At this point, you should be able to feel a loss of moisture.

Continue drying for intervals of 1 to 2 minutes until the sample feels almost completely dry, stirring between intervals. Weigh the sample to determine weight loss. Now, dry the sample for approximately 30 seconds and reweigh. Repeat the 30-second drying intervals until the weight of the dish plus sample ceases to change. Record this as weight C (Step 4).

Different forages require different drying times. Shelled corn may take as long as 15 minutes; haylage, 5 minutes or less. Experience will tell you how much drying time your samples require. To prevent burning, check samples at frequent intervals as they approach dryness.

A sample may feel dry, yet contain as much as 10 percent moisture. The only way to ensure a sample is 100 percent dry is to check the weight after each 30-second drying interval. If the weight is still changing, moisture is still being driven off. If the weight is constant after three 30-second drying intervals, stop. All the moisture is gone and the sample is 100 percent dry. Do not dry further as carbohydrate will be volatilized and moisture will be over-estimated. Stop before charring occurs.

A trial run to gain experience in using microwave is recommended.

Total drying times (Table 1) are approximate. For example, if your sample initially doesn't change much during 1-1/2 minutes of drying, leave it for 2-1/2 minutes at a time. Take care to prevent charring or burning of forage sample. Attend drying procedures at all times as a fire is always a potential risk if over drying and charring occurs. Do not send these samples for forage testing. Fiber and protein concentrations could be altered and heat damage and protein binding are possible.

Table 1

Approximate total drying time for forage samples

- Haylage
4 to 15 minutes
- High moisture corn grain
10 to 15 minutes
- Alfalfa silage
5 to 6 minutes
- Corn silage and fresh material
8 to 20 minutes

Step 4

Calculate percent moisture

- (A) Weight of empty paper plate or bag.
- (B) Weight of wet sample + paper plate or bag.
- (C) Weight of dry sample + paper plate or bag.

Subtract plate or bag weight (A) from both wet weighing (B) and dry weighing (C).

Line 1: B-A

Line 2: C-A

Percent moisture = (Line 1 - Line 2)/Line 1 x 100

Example of moisture calculation

(A) Bag weight = 10 grams

(B) Wet sample weight + bag = 90 grams

(C) Dry sample weight + bag = 70 grams

Line 1: 90 - 10 = 80 grams (wet sample)

Line 2: 70 - 10 = 60 grams (dry sample)

$$\frac{80 - 60}{80} \times 100 = 25 \text{ percent}$$

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Related MU Extension publications

- G1955, Large Round Bales: Management
<http://extension.missouri.edu/publications/DisplayPub.aspx?P=G1955>
- G4575, Making and Storing Quality Hay
<http://extension.missouri.edu/publications/DisplayPub.aspx?P=G4575>

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