# Moisture Determination of Meat Comparing Automated Thermogravimetric and Air Oven Loss-on-Drying Techniques

Jenifer Laurin[1], Gabriela Schmidt[2], Michael Jakob[2], Lloyd Allen[1] | LECO Corporation, Saint Joseph, Michigan, USA[1]; LECO European Applications and Technology Center, Berlin, Germany[2]

## Introduction

Accurate determination of moisture in meat provides important information related to the product's quality and safety. One of the most common moisture determination methods is **mass loss-on-drying** utilizing an air oven. This technique involves recording the sample mass before and after exposure to an elevated temperature in an oven with air ventilation. The resulting sample mass loss is calculated and represents the moisture content of the sample.

The AOAC Moisture in Meat Method (Method 950.46) utilizes the air oven loss-on-drying technique that is widely performed in the food industry. The LECO TGM800 is an automated thermogravimetric moisture determinator, which meets the AOAC method requirements for sample mass, oven temperature, and air flow, while providing additional benefits. Specific advantages of the TGM800 include improved work flow efficiency, minimal operator time, and a sample batch throughput of up to 16 samples. The instrument also incorporates automated end point recognition based upon sample mass constancy, delivering optimal analysis times.

This poster presentation covers the comparison of moisture loss-on-drying determination utilizing the TGM800 and the AOAC method. A variety of meat samples were analyzed utilizing the TGM800 and an air oven loss-on-drying technique following AOAC Method 950.46 in an inter-laboratory comparison study. Several methodologies, including decreased sample mass and the addition of quartz sand to the sample, were investigated to achieve improved precision and reduced analysis time.

## Reference Methods

- AOAC Official Method 950.46 Moisture in Meat
- AOAC Official Method 983.18 Meat and Meat Products

## TGM800 Theory of Operation

The TGM800 is a thermogravimetric moisture determinator designed to indirectly determine moisture content of materials using a mass loss-on-drying technique. Mass loss of the sample is measured as a function of the oven temperature by controlling the atmosphere and ventilation rate. The instrument consists of a computer, an integrated four-place balance, and a multiple sample oven that allows up to 16 samples to be analyzed simultaneously with a maximum temperature of 175 °C.

### Key Features

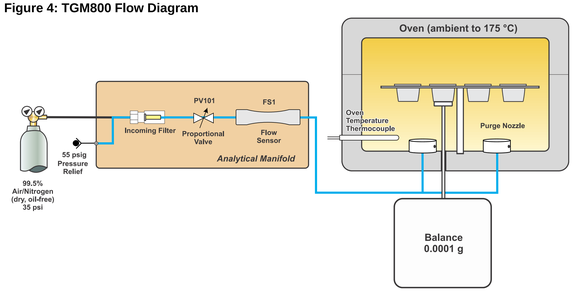
- **Supports 1.5 in diameter (1 g nominal mass) aluminum foil crucibles**
- **Supports 2.4 in diameter (3 g nominal mass) aluminum foil crucibles**
- **Analysis can be performed in air or nitrogen atmosphere**
- **Automated crucible and sample mass recording**
- **Optional fixed time or constancy method parameters**

**Figure 1: TGM800**

**Figure 2: Sample carousel using 1.5 in aluminum foil crucible (16 position)**

**Figure 3: Sample carousel using 2.4 in aluminum foil crucible (10 position)**

**Figure 4: TGM800 Flow Diagram**




## Methodology

**AOAC Official Method 950.46 Moisture in Meat (Manual Method)**

In an effort to achieve a final sample mass of ~2 g as stated in the AOAC method, ~6.5 g of prepared meat sample was weighed into an aluminum dish. In accordance with the AOAC method, the dimensions of the dish used were ≥50 mm diameter and ≤40 mm deep. The sample was dried in an air oven at 125 °C to constant weight (~2-4 hours). The dish was covered before removal from the oven, transferred to a desiccator, and cooled before recording the final mass.

**AOAC Official Method 983.18 Meat and Meat Products (Sample Preparation)**

The meat sample was cut into pieces ≤ 2 inches in size and transferred to a food processor. The sample was then processed for a total of 2 minutes, stopping every 30 seconds to wipe down the bowl. The sample was stored in an air-tight container until analyzed.

## Moisture Analysis Parameters

**Table 1: Manual Oven Loss-on-Drying Method Parameters**

| Method | AOAC 950.46 (LECO USA) | AOAC 950.46 (LECO Germany) |
|---|---|---|
| Crucible Type | Aluminum Dish | Aluminum Dish |
| Nominal Mass | ~6.5 g | ~6.5 g |
| Oven Temperature | 125 °C | 125 °C |
| Hold Time | 240 minutes | 240 minutes |

**Table 2: TGM800 Method Parameters (LECO USA)**

| Parameters | Method 1* | Method 2 | Method 3 | Method 4 |
|---|---|---|---|---|
| Quartz Sand | None | Mixed with ~3 g | None | Mixed with ~0.5 g |
| Nominal Mass | ~6.5 g | ~6.5 g | ~1 g | ~1 g |
| Crucible Type | 2.4 in Ø Al Foil | 2.4 in Ø Al Foil | 1.5 in Ø Al Foil | 1.5 in Ø Al Foil |
| Start Temperature | Ambient | Ambient | Ambient | Ambient |
| End Temperature | 125 °C | 125 °C | 125 °C | 125 °C |
| Ramp Rate | 20.0 °C/min | 20.0 °C/min | 20.0 °C/min | 20.0 °C/min |
| Hold Time | 30 min | 30 min | 30 min | 30 min |
| Ventilation Flow Rate | 5.0 LPM | 5.0 LPM | 5.0 LPM | 5.0 LPM |
| Final Mass | At Constancy | At Constancy | At Constancy | At Constancy |
| Constancy Level | 0.0020 g | 0.0100 g | 0.0005 g | 0.0020 g |

**Table 3: TGM800 Method Parameters (LECO Germany)**

| Parameters | Method 1* | Method 2 | Method 3 | Method 4 |
|---|---|---|---|---|
| Quartz Sand | None | Mixed with ~3 g | None | Mixed with ~0.5 to 0.8 g |
| Nominal Mass | ~6.5 g | ~6.5 g | ~1 g | ~1 g |
| Crucible Type | 2.4 in Ø Al Foil | 2.4 in Ø Al Foil | 1.5 in Ø Al Foil | 1.5 in Ø Al Foil |
| Start Temperature | Ambient | Ambient | Ambient | Ambient |
| End Temperature | 125 °C | 125 °C | 125 °C | 125 °C |
| Ramp Rate | 20.0 °C/min | 20.0 °C/min | 20.0 °C/min | 20.0 °C/min |
| Hold Time | 30 min | 30 min | 30 min | 30 min |
| Ventilation Flow Rate | 5.0 LPM | 5.0 LPM | 5.0 LPM | 5.0 LPM |
| Final Mass | At Constancy | At Constancy | At Constancy | At Constancy |
| Constancy Level | 0.0020 g | 0.0100 g | 0.0005 g | 0.0020 g |

*Method 1 meets the requirements of AOAC Official Method 950.46 Moisture in Meat

## Sample Description

**Three commercial meat samples were purchased representing a variety of meat product matrices, then prepared according to AOAC 983.18**

### LECO USA

**Chicken**
- Chicken Thigh
- Boneless
- Skinless

**Beef**
- Eye of Round
- Lean
- Boneless

**Salmon**
- Sockeye
- Atlantic
- Boneless

### LECO Germany

**Chicken**
- Chicken Thigh with Back Piece
- Bone removed during preparation
- Skin removed during preparation

**Beef**
- Topside
- Lean
- Boneless

**Salmon**
- Aquaculture
- Norway
- Boneless

## Sample Results

**Chart 1: Moisture Results (LECO USA)**

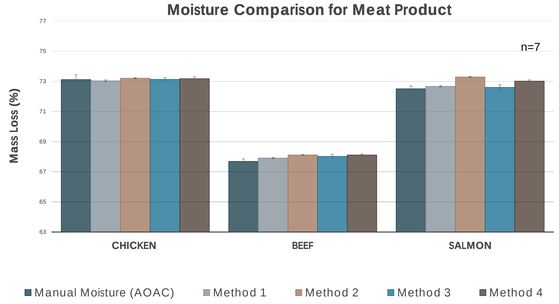



**Chart 2: Moisture Results (LECO Germany)**

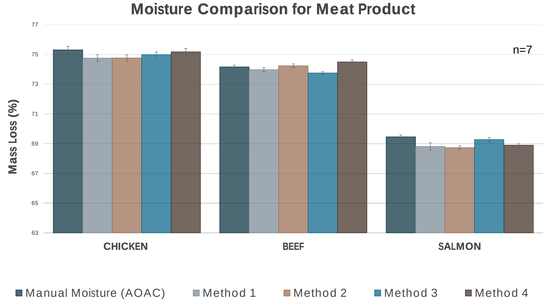



**Chart 3: Analysis Time Results (LECO USA)**

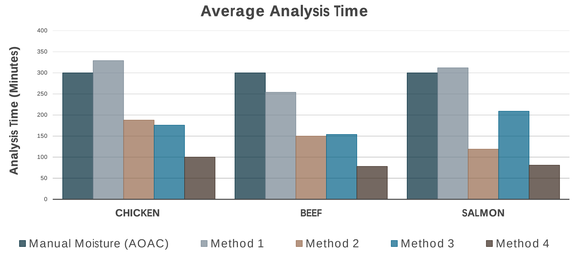
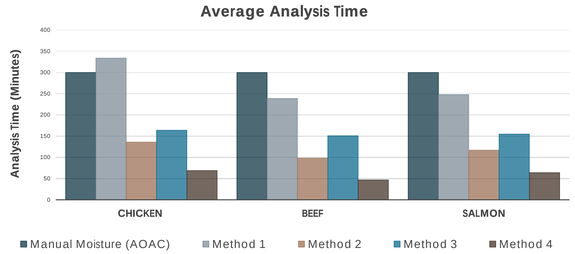



**Chart 4: Analysis Time Results (LECO Germany)**




## Conclusion

The objective of this poster presentation was to demonstrate the analytical performance and application capabilities of the TGM800 utilizing multiple method parameters in comparison with the air oven method outlined in the AOAC method.

**Benefits of determining moisture in meat products utilizing the TGM800 include:**

- **Ability to follow AOAC 950.46 methodology**
- **Ability to deviate from the AOAC method by:**
  - **Mixing quartz sand with the sample to increase thermal transfer, resulting in reduced sample analysis time and improved precision**
  - **Analyzing a decreased sample mass and utilizing the constancy option, resulting in a reduced sample analysis time**
  - **Analyzing a decreased sample mass mixed with sand, resulting in further reduced sample analysis time and improved precision**

The TGM800 moisture results obtained by LECO USA and LECO Germany utilizing the various method modifications were comparable to the results obtained using the manual AOAC method. The TGM800 moisture results demonstrated improved precision in comparison to the manual AOAC method, with some samples displaying as much as an order of magnitude improvement in precision. When using method parameters compliant with the manual AOAC method, the total analysis time using the TGM800 (Method 1) was comparable to the analysis time using the manual AOAC method. By modifying the methodology, the analysis time was reduced by 130 to 225 minutes compared to the manual method.

The TGM800 provides the user with flexible method settings, automation, and hardware capabilities that maximizes moisture determination efficiency, productivity, and analytical performance. This is accomplished while offering the ability to meet the AOAC primary loss-on-drying method requirements for sample mass, oven temperature, and ventilation.