



BY AMERICAN MEAT SCIENCE ASSOCIATION

Avoiding Temperature Variations in Whole-Muscle Cooked Products

Why is temperature control important in whole-muscle cuts?

Whole-muscle cuts like hams and beef roasts require precise temperature control to ensure uniform cooking, moisture retention, and food safety compliance. Because these products have varying thickness and composition, inconsistent cooking can lead to undercooked portions, affecting texture, yield, and safety—especially when targeting final temperatures below 145°F.







What is heat transfer, and how does it affect cooking?

Heat transfer is the movement of thermal heat energy from a warmer location to a colder location. The greater the temperature difference between the oven and the meat's core, the faster cooking occurs.

- In uniform products (e.g., bologna logs), heat flows predictably.
- In irregularly shaped products like bone-in hams, multiple core locations require careful monitoring to ensure even cooking.

What is mass transfer, and why does it matter?

Mass transfer refers to moisture movement within meat during cooking. Moisture migrates from the interior to the surface, then evaporates into the air. Several factors influence moisture movement:

-  **Product temperature**
-  **Composition (lean to fat ratio)**
-  **Moisture content**
-  **Water-holding capacity**

Since most moisture loss occurs from the surface, evaporation must be controlled to maintain yield and texture.

Thermodynamic Changes During Cooking

Meat cooking involves simultaneous heat and mass transfer, meaning two processes occur at the same time. The heat transfer triggers thermodynamic changes (how energy moves and affects physical properties), while moisture and other components shift within and out of the meat.

- 1** Heat transfer from the air to the product – The oven or cooking environment delivers thermal energy to the meat's surface.
- 2** Heat transport within the meat – Thermal energy moves deeper into the product, cooking the interior.
- 3** Moisture transport inside the muscle – Water migrates toward the surface due to temperature changes and pressure differences.
- 4** Moisture evaporation from surface to air – As heat is applied, water at the surface evaporates, contributing to cooking loss.

Because meat essentially undergoes a high-temperature drying process, controlling these heat and moisture interactions is essential for maintaining yield, texture, and uniform doneness.

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How can processors reduce temperature variation?

1

Batch Products Based on Characteristics

Sorting hams by fat content or ensuring roasts are evenly injected can improve consistency. Higher moisture levels in one part of a roast may cause uneven heating.

2

Standardize Starting Temperatures

Allow products to rest after injection, trimming, or processing to ensure uniform temperature before cooking.

3

Optimize Oven Conditions

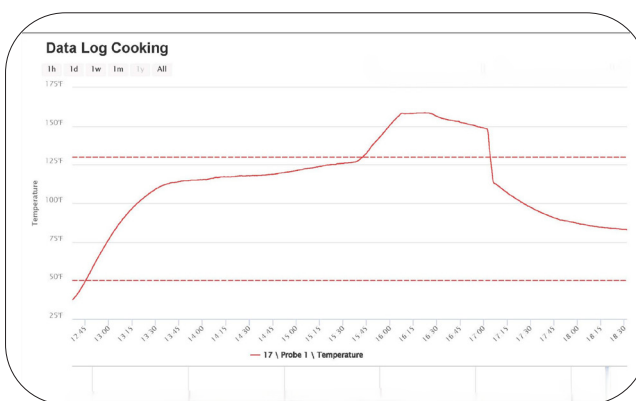
Be aware of oven hot and cold spots and load products accordingly. Cooking in high humidity improves heat transfer and stabilizes oven temperature.

4

Use Multiple Recording Thermometers

Measure internal temperature in multiple locations using more than one thermometer to help detect inconsistencies. Visual appraisals alone may not be reliable indicators of uniform cooking.

Examples of Temperature Recording Devices



By applying these strategies, processors can improve temperature uniformity, maintain quality, and enhance food safety in whole-muscle products.

