Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 26

2012

Combined microwave and convection cooking increases post-cooking temperature rise of beef Biceps femoris muscles more than convection cooking

A. Gaschler

Michael E. Dikeman

Recommended Citation

Gaschler, A. and Dikeman, Michael E. (2012) "Combined microwave and convection cooking increases post-cooking temperature rise of beef Biceps femoris muscles more than convection cooking," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. https://doi.org/10.4148/2378-5977.1429

Combined microwave and convection cooking increases post-cooking temperature rise of beef Biceps femoris muscles more than convection cooking

Abstract

Combined microwave and convection cooking has gained popularity in the last 20 years because of more accurate heat control and more efficient use of energy. Combination microwave/convection cooking allows for more rapid cooking, but it does not have the same even heat distribution as convection cooking. Cooking is a critical stage when preparing meat. The main factors to consider during cooking are: temperature on the surface of meat, internal temperature throughout, and the method of heat transfer. Temperature on the surface and method of heat exchange primarily affect surface color and aroma, whereas internal temperature affects protein structure and flavor as well as aroma. At any temperature above 230°F, Maillard browning reactions start to occur and give meat its typical brown, caramelized appearance; however, high humidity prevents Maillard browning from occurring and dilutes flavor and odor components. All sensory attributes can, therefore, be significantly influenced by the cooking technique used. Different cooking methods allow for tenderness, flavor development, and color changes, all of which can be either acceptable or unacceptable for consumers. Different cuts of beef are cooked using different cooking methods to ensure that even a low-quality cut of meat can be acceptable for consumption. The objectives of our study were to investigate the differences between convection cooking and a combination of microwave and convection cooking and endpoint temperatures to observe how these factors affect post-cooking temperature rise, cooking yields, and tenderness.

Keywords

Cattlemen's Day, 2012; Kansas Agricultural Experiment Station contribution; no. 12-231-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1065; Beef Cattle Research, 2012 is known as Cattlemen's Day, 2012; Beef; Temperature; Biceps femoris; Microwave; Convection cooking; Cooking yields

Combined Microwave and Convection Cooking Increases Post-Cooking Temperature Rise of Beef *Biceps femoris* Muscles More Than Convection Cooking

A. Gaschler and M.E. Dikeman

Introduction

Combined microwave and convection cooking has gained popularity in the last 20 years because of more accurate heat control and more efficient use of energy. Combination microwave/convection cooking allows for more rapid cooking, but it does not have the same even heat distribution as convection cooking. Cooking is a critical stage when preparing meat. The main factors to consider during cooking are: temperature on the surface of meat, internal temperature throughout, and the method of heat transfer. Temperature on the surface and method of heat exchange primarily affect surface color and aroma, whereas internal temperature affects protein structure and flavor as well as aroma. At any temperature above 230°F, Maillard browning reactions start to occur and give meat its typical brown, caramelized appearance; however, high humidity prevents Maillard browning from occurring and dilutes flavor and odor components. All sensory attributes can, therefore, be significantly influenced by the cooking technique used. Different cooking methods allow for tenderness, flavor development, and color changes, all of which can be either acceptable or unacceptable for consumers.

Different cuts of beef are cooked using different cooking methods to ensure that even a low-quality cut of meat can be acceptable for consumption. The objectives of our study were to investigate the differences between convection cooking and a combination of microwave and convection cooking and endpoint temperatures to observe how these factors affect post-cooking temperature rise, cooking yields, and tenderness.

Experimental Procedures

Eight bottom round muscles (*Biceps femoris*) were cut into 4 sections (approximately 2 to 3 lb each) at approximately 18 to 19 days postmortem, making a total of 32. Roasts were cooked in a convection/microwave oven (Amana Microwave Oven with Convection, Model AMC71597AB, Maytag Corp., Benton Harbor, MI) that allowed for 2 cooking methods: convection and a combination of microwave and convection cooking. Roasts were cooked at 225°F to endpoint temperatures of 145 or 165°F. A 2 × 2 factorial design was used for investigating interactions between cooking method and endpoint temperature. To ensure that the endpoint temperature was reached during the combination of microwave and convection cookery, roasts were checked with a calibrated thermocouple every 15 minutes until the roasts were close to reaching their endpoint temperature. When the temperature approached its target, the temperature was taken more often (every 2 to 5 minutes) to ensure that the desired endpoint temperature was reached. When the temperature was achieved, roasts were removed from the oven, weighed, and the post-cooking temperature rise was monitored using a thermocouple logging system. When the temperature dropped 1° after the post-cooking temperature rise, roasts were weighed and samples were taken to measure tenderness using the slice shear force procedure. Cooking loss was calculated using the formula ([(thawed weight – cooked weight) / thawed weight] × 100), whereas total cooking loss was calculated using [(thawed weight – cooked weight after final temperature was reached/thawed weight] × 100.

The data were analyzed as a completely randomized block design with a 2 × 2 treatment structure. The blocking term was roast and the main effects were cookery method and endpoint temperature. Means were separated ($P < 0.05$) using the Least Significant Difference procedure (SAS Inc., Cary, NC) when respective F-tests were significant ($P < 0.05$).

Results and Discussion

Means for cooking losses are reported in Table 1. We observed a cooking method × endpoint temperature interaction ($P < 0.0001$) for both cooking loss and total cooking loss. For both endpoint temperatures, the combination of microwave and convection cooking resulted in a greater cooking loss and total cooking loss than convection cooking. A greater loss was observed when cooking to an endpoint temperature of 165°F versus 145°F. Convection cooking to an endpoint temperature of 145°F had the least cooking loss, and microwave and convection cooking to 165°F had the most cooking loss. The difference between cooking methods at 145°F was quite large, with convection cooking having much lower losses than microwave and convection cooking.

The maximum temperature reached was recorded in each roast after reaching its targeted endpoint temperature. Microwave and convection cooking showed a much greater ($P < 0.05$) temperature rise when compared with convection cooking (14.4° F greater rise; Table 2). There was no difference in post-cooking temperature rise between roasts cooked to 145°F and those cooked to 165°F. The time required by each roast to reach its maximum temperature was not different between cooking methods (Table 2), but the roasts cooked to an endpoint temperature of 145°F took longer ($P < 0.05$) to reach their highest post-cooking temperature than roasts cooked to an endpoint temperature of 165°F. In other words, rate of post-cooking temperature rise was slower at the lower endpoint temperature. There were no main effects or interactions for slice shear force (Table 2) due to cooking method. All roasts were comparatively tough, primarily because they contained relatively large amounts of collagen.

Implications

When cooking with microwave and convection in combination, one should remove roasts from the oven at an approximately 14°F lower temperature than for convection cooking to result in the same final endpoint temperature.

Table 1. Cooking method × endpoint temperature interaction means and standard errors (SE) for cooking and total cooking losses

	Cooking method				
	Microwave/convection		Convection		
Trait	145°F	165°F	145°F	165°F	SE
Cooking loss, %[1]	30.47[b]	35.14[a]	16.2[d]	28.02[c]	0.84
Total cooking loss, %[2]	37.04[b]	40.61[a]	17.7[d]	32.25[c]	0.97

[1] Cooking loss = [(thawed weight – cooked weight)/thawed weight] ×100.
[2] Total cooking loss = [(thawed weight – cooked weight after final temperature reached)/thawed weight] × 100.
[abcd] Means within a trait with different superscripts letters differ ($P < 0.05$).

Table 2. Cooking method and endpoint temperature main effect means and standard errors (SE)

	Cooking method			Endpoint temperature		
Trait	Microwave/ convection	Convection	SE	145°F	165°F	SE
Maximum temperature reached	171.03[a]	156.59[b]	1.87	153.23[b]	174.40[a]	1.80
Minutes to reach maximum temperature	14.06	12.59	1.11	16.57[a]	10.08[b]	1.07
Slice shear force, lb	49.19	45.66	3.30	46.39	48.46	3.39

[ab] Means within a trait and main effect with different superscripts differ ($P < 0.05$).