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## Color of cooked ground beef patties is affected by cooking rate and post-cooking holding time (2006)

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## **COLOR OF COOKED GROUND BEEF PATTIES IS AFFECTED BY COOKING RATE AND POST-COOKING HOLDING TIME**

*S. M. Ryan, M. Seyfert, M. C. Hunt, and R. A. Mancini*

### **Summary**

Two experiments investigated the effects of cooking rate and post-cooking holding time on the internal cooked color of ground beef patties. In Experiment 1, patties were cooked rapidly (1.8°F/second) or slowly (0.4°F/second). At temperatures below 180°F, rapidly cooked patties were redder and appeared less well done than those cooked slowly. All slowly cooked patties appeared well done, even at unsafe final internal temperatures. In Experiment 2, patties were cooked rapidly and held for 1, 3, 6, or 12 minutes after cooking. Increasing the post-cooking holding time to 6 minutes after rapid cooking decreased pinkness and maximized well-done appearance. This allowed ground beef patties to be cooked to a lower temperature, likely preserving juiciness and flavor. Employing either a slow cooking rate or rapid cooking with a post-cooking holding time will foster a well-done appearance. Internal cooked color is not an adequate indicator of ground beef doneness. Only strict temperature control and monitoring can ensure product safety.

### **Introduction**

Due to risks associated with pathogenic bacteria, it is very important not to consume undercooked ground beef patties, but consumers may do so without realizing it. In fast-food restaurants, consumers often judge ground beef doneness by its color. Consumers frequently believe a brown internal color indicates that ground beef is fully cooked and safe to eat, whereas they think that a pink color

means it has been undercooked and is unsafe to eat. Both assumptions may be wrong. Two occurrences cause this thinking to be unreliable and incorrect: persistent pinking and premature browning. Persistent pinking occurs when a pinkish internal color remains after patties have been cooked to a safe endpoint temperature, whereas premature browning occurs when ground beef patties appear well done when they have not been cooked to a safe endpoint temperature.

Internal cooked color is influenced by many factors, but two factors that have received little attention are cooking rate and post-cooking holding time. Fast-food restaurants use rapid cooking rates to cook ground beef, and frequently hold product after cooking for some time before consumption. The objective of our study was to examine the effects of cooking rate and post-cooking holding time on the internal color of ground beef.

### **Experimental Procedures**

Ground beef patties, similar to those used in fast-food restaurants, were cooked by using one of two cooking devices: a flat surface grill (slow cooking, 0.4°F/second) that required flipping during cooking or a double-sided, clam-shell grill (rapid cooking, 1.8°F/second) that cooked both sides of the patty at once. Patties held after cooking were placed in a 220°F warmer for the assigned holding time. In Experiment 1, ground beef patties were cooked rapidly or slowly to 1 of 5 internal

temperatures (150, 160, 170, 180, or 190°F). In Experiment 2, patties were cooked rapidly to 160, 170, or 180°F and subsequently were held for 1, 3, 6, or 12 minutes.

Instrumental redness ( $a^*$ ) and visual color were evaluated on the interior of the patties after cooking. The following visual scale was used: 1 = raw red center, pink border, tan edge (medium rare); 2 = reddish-pink center, pink border, tan edge; 3 = slightly pink center, light brown to tan edge (medium); 4 = tan/brown center and edges, no evidence of pink; and 5 = dry, brown throughout (well done).

### **Results and Discussion**

In Experiment 1, rapidly cooked patties were redder (greater  $a^*$  values) than slow-cooked patties at all temperatures except 180°F (Table 1). In general, increasing temperature had the predictable effect of decreasing interior redness ( $a^*$  values), regardless of cooking rate. Visually, slowly cooked patties always appeared more well done than did rapidly cooked patties, except at 190°F (Table 1). Rapidly cooked patties cooked to 170°F or less remained slightly pink, whereas patties cooked rapidly to 180°F and above appeared well done. All temperatures for slowly cooked patties resulted in a well-done appearance (visual score greater than 4.0). Thus, at 150°F, slowly cooked patties appeared well done even though they had not reached temperatures ensuring safety. Patties cooked rapidly to 160 or 170°F, although safe, might be rejected by consumers.

In Experiment 2, increasing the post-cooking holding time of ground beef patties decreased their redness and increased their well-done appearance (Table 2). As post-cooking holding time increased to 6 minutes, a minimum redness ( $a^*$  values) was attained for patties cooked rapidly to 160 or 170°F. After 12 minutes of holding time, patties from all temperatures were similar. A well-done appearance in rapidly cooked patties was attained by cooking to 170 or 180°F and holding for 1 minute, or cooking to 160°F and holding for 6 minutes.

These experiments reaffirmed that internal cooked color is not an adequate indicator of ground beef doneness. Consumers may reject patties rapidly cooked to 160 or 170°F, with their slightly pink appearance, because of unfounded fears that they are undercooked and unsafe, although the patties are, in fact, safe to eat. To alleviate this concern, restaurants may overcook patties (to 180°F or higher) to ensure a well-done appearance. This prolonged cooking may eliminate the undesirable pink color, but not without a loss of quality. The real concern comes when patties are slow cooked, because they will appear well done at temperatures below those ensuring safety (150°F). Ironically, consumers might not question the safety of such patties on the basis of their appearance. For fast-food restaurants to maintain consumer acceptability and preserve eating quality, while maintaining safety standards and high-volume output, ground beef patties should be cooked to a minimum safe temperature (160°F) and then subjected to a least a 6-minute post-cooking holding time.

**Table 1. Internal cooked color traits of quarter-pound ground beef patties cooked rapidly (1.8°F/second) or slowly (0.4°F/second)**

Trait	Cooking Rate	Internal Endpoint Temperature (°F)					SEM <sup>1</sup>
		150	160	170	180	190	
a* (redness)	Slow	10.5 <sup>bxy</sup>	11.3 <sup>bx</sup>	9.8 <sup>by</sup>	10.7 <sup>axy</sup>	8.3 <sup>bz</sup>	0.62
	Rapid	18.5 <sup>aw</sup>	14.7 <sup>ax</sup>	12.6 <sup>ay</sup>	11.6 <sup>ayz</sup>	10.5 <sup>az</sup>	
Visual color <sup>2</sup>	Slow	4.2 <sup>az</sup>	5.0 <sup>ay</sup>	5.0 <sup>ay</sup>	5.0 <sup>ay</sup>	5.0 <sup>ay</sup>	0.17
	Rapid	2.5 <sup>bz</sup>	3.1 <sup>by</sup>	3.4 <sup>bx</sup>	4.1 <sup>bw</sup>	4.8 <sup>av</sup>	

<sup>1</sup>Standard error of the mean.

<sup>2</sup>3 = slightly pink center, light brown to tan edge (medium appearance); 5 = dry, brown throughout (well-done appearance).

<sup>a,b</sup>Means having different superscript letters in a column within a trait differ (P<0.05).

<sup>v,w,x,y,z</sup>Means having different superscript letters in a row differ (P<0.05).

**Table 2. Internal cooked color traits of quarter-pound ground beef patties cooked rapidly (1.8°F/second) and held after cooking**

Trait	Hold Time (minutes) <sup>1</sup>	Internal Endpoint Temperature (°F)			SEM <sup>2</sup>
		160	170	180	
a* (redness)	1	12.7 <sup>ax</sup>	12.0 <sup>ay</sup>	10.9 <sup>bz</sup>	0.30
	3	12.6 <sup>ay</sup>	11.5 <sup>abz</sup>	11.4 <sup>abz</sup>	
	6	11.5 <sup>by</sup>	11.2 <sup>byz</sup>	10.8 <sup>abz</sup>	
	12	11.1 <sup>bz</sup>	11.2 <sup>bz</sup>	11.4 <sup>az</sup>	
Visual color <sup>3</sup>	1	3.6 <sup>az</sup>	4.0 <sup>ay</sup>	4.9 <sup>ax</sup>	0.11
	3	3.4 <sup>az</sup>	4.1 <sup>ay</sup>	4.9 <sup>ax</sup>	
	6	4.0 <sup>bz</sup>	4.3 <sup>by</sup>	4.9 <sup>ax</sup>	
	12	4.2 <sup>bz</sup>	4.3 <sup>bz</sup>	4.9 <sup>ay</sup>	

<sup>1</sup>Time (minutes) patties were held at 220°F after rapid cooking.

<sup>2</sup>Standard error of the mean.

<sup>3</sup>3 = slightly pink center, light brown to tan edge (medium appearance); 5 = dry, brown throughout (well-done appearance).

<sup>a,b</sup>Means having different superscript letters in a column within a trait differ (P<0.05).

<sup>x,y,z</sup>Means having different superscripts in a row differ (P<0.05).