INCIDENCE OF PREMATURE BROWNING DURING COOKING IN GROUND BEEF PURCHASED AT RETAIL

M. C. Hunt, K. M. Killinger, and R. E. Campbell

Summary

We measured the incidence of premature browning during cooking in ground beef that was purchased from retail supermarkets and prepared using common household procedures. Patties made from meat on the outer portion of the packages purchased in the morning had the highest incidence of premature browning (62.5%). Patties from inner portions of packages purchased in the afternoon, refrigerated, and prepared the next morning were more ($P<0.05$) purple and had the lowest incidence (25%) of premature browning. Overall incidence of premature browning averaged 47%. Because internal cooked color of ground beef is such an unreliable indicator of doneness, temperature measurements should be used to verify that safe endpoint temperatures have been reached.

Introduction

Internal cooked color of beef steaks and roasts changes from red to pink to brown as their doneness increases. Unfortunately, the internal cooked color of ground beef is not a reliable indicator of doneness. Sometimes patties may appear brown, slightly pink, or have a persistent pink/red color even though cooked to the same temperature. ***Premature browning*** is a vitally important food safety issue, because patties may appear fully cooked (brown) even though they have not reached an internal temperature high enough to kill pathogens that might be present. The USDA (1997) recommends that ground beef patties be cooked to160EF, with no reference to internal color. The FDA (1993) recommends that food service establishments cook ground beef to 155EF and hold for 15 sec. However, these combinations of time-temperature may result in patties that are fully cooked but have a pink internal cooked color that consumers think is unsafe.

Because no data are available on the occurrence of premature browning, we determined its incidence in ground beef purchased from retail supermarkets and prepared using common household procedures.

Experimental Procedures

Ground beef (1 lb packages, 20% fat) was purchased from two retail stores twice each day for 8 days. Product was purchased in the morning (<2 hr after grinding, based on information provided by the store meat managers), formed into patties, and cooked within 1 hour of purchase. Ground beef packages purchased in the afternoon were refrigerated (36EF) overnight, and patties were formed and cooked on the following morning. One 1/4 lb. patty was made from the surface layer (outer 5/8 in.) of each package. This portion appeared bright red (predominantly oxymyoglobin) in packages purchased in the morning, but both oxy- and metmyoglobin (the brown pigment) were present in packages purchased in the afternoon. A second patty was made with meat from the inner, central-bottom portions of the packages. The pigments seen in the inner patties from the morning purchases appeared to be a combination of oxy- and metmyoglobin, whereas the internal samples from afternoon purchases seemed to contain more deoxymyoglobin with small amounts of metmyoglobin. All patties were cooked to an internal temperature of 131EF (an unsafe endpoint that measures premature browning) on an electric griddle at a surface tempera-

ture of 350EF. Internal temperature of the patties was measured by intermittently inserting an 18-gauge hypodermic thermocouple into their centers.

Prior to cooking, the outer surfaces of each patty were visually scored for color, using a scale of: 1=purple-red, 2=dark reddish purple, 3=bright red, 4=brownish-red, 5=very brown. Visual scoring was done under 100 foot-candles of deluxe warm-white fluorescent lighting. The interior color of the patties was assumed to be the same as the exterior, because cooking occurred immediately after patty formation. In addition, exterior color was measured using a portable Minolta colorimeter to determine CIE L*a*b* values.

Cooked patties first were cut perpendicular to the flat surface, and the interiors were scored visually. Then the half-circles of the patties were cut in the center parallel to the flat surface, and visual scores and three instrumental readings were taken. The scale for internal cooked visual color was: 1=very dark red to purple, 2=bright red, 3=very pink, 4=slightly pink, 5=tan (no evidence of pink). Data were analyzed as a factorial, split-plot design.

Results and Discussion

Patties cooked to 131EF and showing a visual color score of 4.0 or higher were considered prematurely brown; in this experiment, 47% (30 of 64) (Fig. 1 totals). The highest incidence of premature browning (62.5%) was found in patties made from the outer portions of packages purchased in the morning (Fig. 1); patties made from the inner portions of those packages had a 43.8% incidence. Of patties made from packages purchased in the afternoon, 56.3% made from the outside were prematurely brown, but only 25% of patties made from the inner portions. Refrigerated overnight storage of ground beef packages reduced the incidence of premature browning by 10 to 40%.

Cooked patties showed significant purchase time by tissue location interactions for a*, saturation index, and hue angle values (Table 1). Patties made from the inner portion of packages purchased in the afternoon and stored overnight had the highest ($P<0.05$) a* (redness) and the lowest hue angle values (less brown). These patties were less likely to appear prematurely brown, probably because more bright red oxymyoglobin had reduced to purple red deoxymyoglobin in the inner portion of the ground beef during overnight storage. In addition, patties made from the outer portion of the packages purchased in the morning had higher ($P<0.05$) hue angle values (more brown) than patties made from the inner portion of packages purchased in either the morning or the afternoon.

Uncooked patty color differed by store (data not shown), but these differences did not affect cooked patty color and the incidence of premature browning.

Visual scores and a* and hue angle values for uncooked patties showed a significant interaction of purchase time by package location (Table 1). Raw patties made from the inner portion of the afternoon-purchased packages were scored visually more ($P<0.05$) purplish-red than patties from other purchase time and location combinations and, thus, had the lowest incidence of premature browning. Ground beef in the inner portion of those packages would be expected to have a change in pigments from oxymyoglobin to metmyoglobin and eventually to deoxymyoglobin and become more purple than meat from either the outer or inner portion of packages purchased in the morning shortly after grinding. Patties formed from ground beef purchased in the afternoon and taken from either the outer or inner package location had lower ($P<0.05$) a* values (redness) than patties formed from ground beef purchased in the morning. Raw patties made from ground beef purchased in the afternoon and formed from the outer portion of the packages had higher ($P<0.05$) hue angle values (indicates more brown) than patties from any other purchase time and location combination.

Incidence of premature browning during cooking of ground beef varied by package

location and time of purchase, as well as home storage time. Our study suggests that a predominance of oxymyoglobin and metmyoglobin, as opposed to deoxymyoglobin, in raw ground beef can lead to premature browning upon cooking. Any practices at stores or during home storage that encourage the formation of deoxymyoglobin should reduce premature browning. The 47% incidence of premature browning in our study indicates that ground beef patty doneness should not be judged by color. The chance of leaving viable pathogenic bacteria was nearly 1 in 2 when a ground beef patty was cooked to a brown color endpoint. This level of risk is unacceptable; thus, consumers must use some form of temperature measurement to determine doneness of ground beef patties.

Table 1. Effects of Purchase Time and Package Location on Visual Color Scores, a* Values, Saturation Index, and Hue Angle of Uncooked and Cooked Ground Beef Patties

		Package Location		
Trait	Purchase Time	Outer	Inner	SE
Uncooked				
Visual[d]	Morning	3.0[a]	3.1[a]	
	Afternoon	2.9[a]	1.8[b]	.20
a* value (redness)	Morning	22.9[a]	21.9[a]	
	Afternoon	18.5[b]	19.3b	.37
Hue angle	Morning	25.8[b]	26.0[b]	
	Afternoon	27.6[a]	26.2[b]	.35
Cooked				
a* value (redness)	Morning	11.7[b]	12.7[b]	
	Afternoon	11.9[b]	14.3[a]	.33
Hue angle	Morning	41.3[a]	38.6[b]	
	Afternoon	40.1[ab]	34.9[c]	.85

[a,b,c]Means within a trait, both morning and afternoon, with a different superscript letter differ P<0.05.
[d]Visual score 1=purple-red, 2=dark reddish purple, 3=bright red.

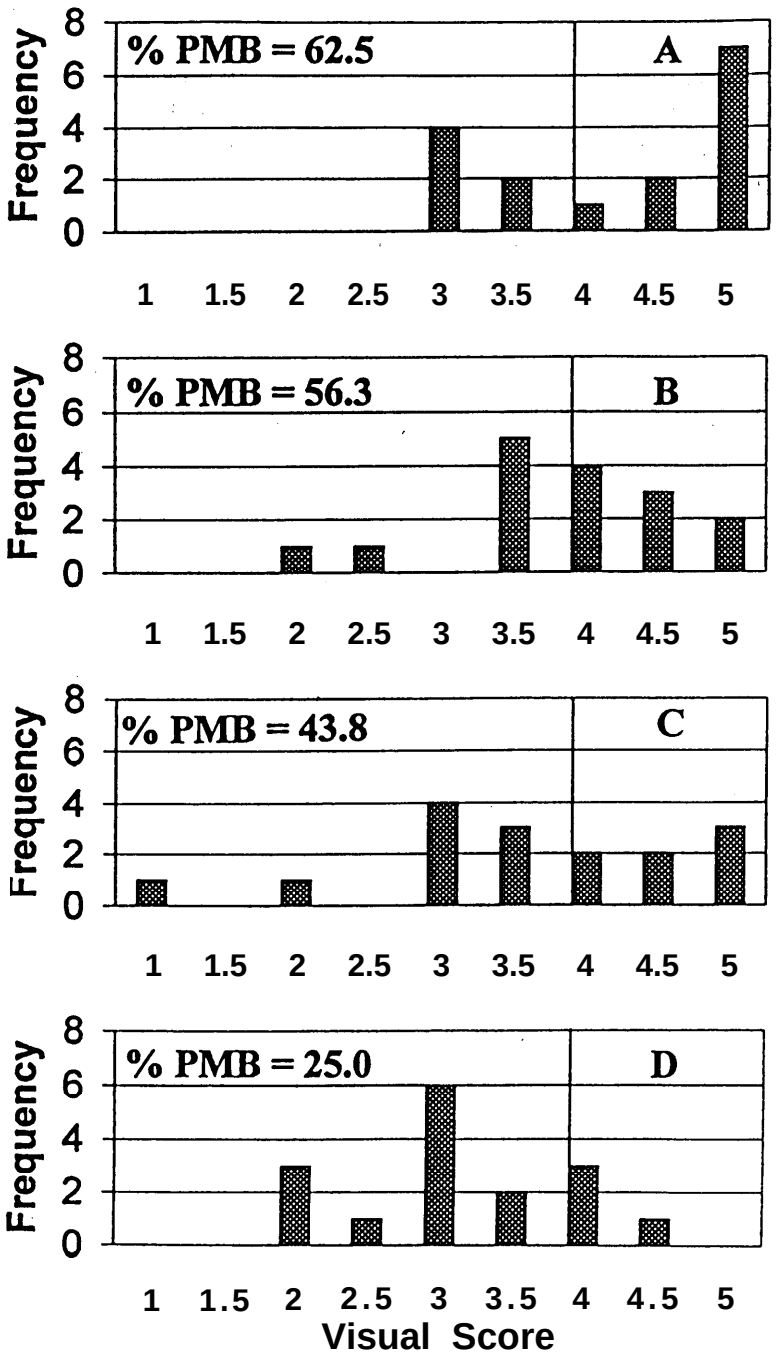

Figure 1. Frequency of Premature Brown Visual Scores ($\geq$ 4.0) for Internal Cooked Color of Ground Beef Patties to 131 ^{o} F. A = ground beef purchased in the morning, patties made from outer 1.5 cm of package; B = ground beef purchased in the afternoon and stored overnight, patties from outer portion of package; C = ground beef purchased in the morning, patties from the inner, central-bottom portion of package; D = ground beef purchased in the afternoon and stored overnight, patties from the inner portion of package.