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# Use of visual appearance as an indicator of degree of doneness in ground beef patties

## Abstract

Outbreaks of food-borne illness have emphasized the need for proper cooking of ground beef patties. Because of difficulties in measuring internal temperature of ground beef patties, visual indicators usually are used to estimate degree of doneness. As internal temperature increases from 130 to 170 °F, the internal appearance is expected to change from very red to brown and juice color from red to clear. Based on ground beef patties from three sources, we found that internal color over-estimated internal temperature. Expressible juice decreased in redness as internal temperature increased but did not run clear even at temperatures over 160 °F. Regardless, expressible juice color was a better indicator of degree of doneness than internal color.

## Keywords

Cattlemen's Day, 1993; Kansas Agricultural Experiment Station contribution; no. 93-318-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 678; Beef; Ground beef; Color; Cookery; End-point temperature; Safety

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# USE OF VISUAL APPEARANCE AS AN INDICATOR OF DEGREE OF DONENESS IN GROUND BEEF PATTIES

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## Summary

Outbreaks of food-borne illness have emphasized the need for proper cooking of ground beef patties. Because of difficulties in measuring internal temperature of ground beef patties, visual indicators usually are used to estimate degree of doneness. As internal temperature increases from 130 to 170°F, the internal appearance is expected to change from very red to brown and juice color from red to clear. Based on ground beef patties from three sources, we found that internal color over-estimated internal temperature. Expressible juice decreased in redness as internal temperature increased but did not run clear even at temperatures over 160°F. Regardless, expressible juice color was a better indicator of degree of doneness than internal color.

(Key Words: Ground Beef, Color, Cookery, End-Point Temperature, Safety.)

## Introduction

The need for thorough cooking of ground beef patties has been identified by USDA as a food safety concern, since cases of food-borne illness have been linked to undercooked ground beef. Individuals at highest risk are the very young, the elderly, and the immunocompromised. Most outbreaks have occurred in smaller food establishments and in homes, likely due to difficulty in monitoring the actual degree of doneness. Large establishments have more carefully controlled cooking procedures to assure that specified end-point temperatures are reached. Ground beef patty shape makes it difficult to measure end-point temperature. Therefore, visual indicators are commonly used. USDA Food Safety and

Inspection Service (USDA-FSIS) developed the following recommendation to assure heating to 160°F. *"Heat all meat patties until they are hot, steaming, and juices run clear. The center of the patty should be grayish-brown with no evidence of pink color."*

As end-point temperature increases, cooked color develops, giving a product the appearance of doneness. However, prior work has shown that the typical development pattern of cooked color does not hold true for all patties. Ground beef patties from high pH raw material (pH > 5.8) have been called 'hard to cook' and tend to remain red at temperatures normally associated with a done appearance. Prior work at Kansas State has shown that patties from D and E maturity cattle (72 months and older), with a normal pH, appear well-done at internal temperatures lower than normal. Therefore, our objective was to determine the effect of several raw material sources and end-point temperatures on internal and expressible juice color of ground beef patties.

## Experimental Procedures

We used three raw material sources: 10 knuckles from A-maturity animals, 10 knuckles from E-maturity Holstein cows, and 5 samples of import trim (approximately 15% fat) from Australia and New Zealand. All raw materials were within the pH range of 5.4 to 5.8 (normal). Knuckles were individually coarsely ground through a 1/4 in. plate, formulated to 15% fat, and finely ground through a 1/8 in. plate. Import trim was handled in a similar manner; however, no additional fat was added. Patties (0.25 lb) were formed, vacuum packaged, and frozen

until cooking. Thawed patties (38.3 °F) were cooked on an electric griddle (325 °F), and internal temperature was monitored using a thermocouple probe. Patties were cooked to 131, 140, 150, 160, or 170 °F internally. Patty internal color and expressible juice color were evaluated visually using a descriptive scale and an instrumental measure of redness.

### Results and Discussion

Although visual color scores became less red ( $P < .05$ ) as temperature increased (Figure 1), the change in color from 131 to 170 °F was not as pronounced as expected. At 131 °F, the patties were expected to look very red and undercooked. However, they were actually slightly pink or essentially tan, both characteristics of a medium degree of doneness. Although visual scores became less red ( $P < .05$ ) with increasing temperature from 131 to 160 °F, internal appearance was more brown than expected. Instrumental evaluation supports the visual appraisal (Figure 2); the patties were already brown at low temperatures. Visually, expressible juice (Figure 1) changed from a dark dull red at

131 °F to a pinkish tan at 170 °F, and that was confirmed by instrumental measures (Figure 2). However, cooking to 170 °F did not produce clear juices, the endpoint dictated by USDA-FSIS.

The internal color of the three raw material sources (Table 1) did not differ ( $P > .05$ ) in visual score, and although significant, differences in instrumental values were small. By instrumental measurement, expressible juice from A-maturity patties was redder than juice from import trim ( $P < .05$ ). Expressible juice from E-maturity patties was intermediate and did not differ ( $P > .05$ ) from juices from A-maturity or import trim.

Expressible juice may be a more reliable indicator of end-point temperature of a ground beef patty than internal patty color. However, juices were not clear at internal temperatures exceeding 160 °F, the USDA-FSIS recommended temperature. Therefore, expressible juice may be more accurately described as lacking redness rather than being clear. Other factors, such as storage time and handling as well as raw material source, may alter cooked color development and should be studied.

**Table 1. Raw Material Effects on Instrumental and Visual Measurements of Internal and Expressible Juice Color of Cooked Ground Beef Patties**

Color Measurement <sup>w</sup>	A-maturity	E-maturity	Import trim
INTERNAL COLOR			
Visual <sup>x</sup>	3.5	3.4	3.6
Instrumental <sup>y</sup>	52.3 <sup>a</sup>	52.8 <sup>a</sup>	54.9 <sup>b</sup>
EXPRESSIBLE JUICE			
Visual <sup>z</sup>	3.0	3.2	3.4
Instrumental <sup>y</sup>	34.2 <sup>a</sup>	38.3 <sup>ab</sup>	46.9 <sup>b</sup>

<sup>ab</sup>Means within a row without a common superscript letter are different ( $P < .05$ ).

<sup>w</sup>Means averaged across the five end-point temperatures.

<sup>x</sup>Color scale: 1 = pink; 2 = moderately pink; 3 = slightly pink; and 4 = brown.

<sup>y</sup>Hue angle:  $HA = \tan^{-1}(b/a)$ . The larger the number the less red the color.

<sup>z</sup>Color scale: 1 = dark, dull red; 2 = red; 3 = pink; 4 = pinkish red; and 5 = yellow, no pink.

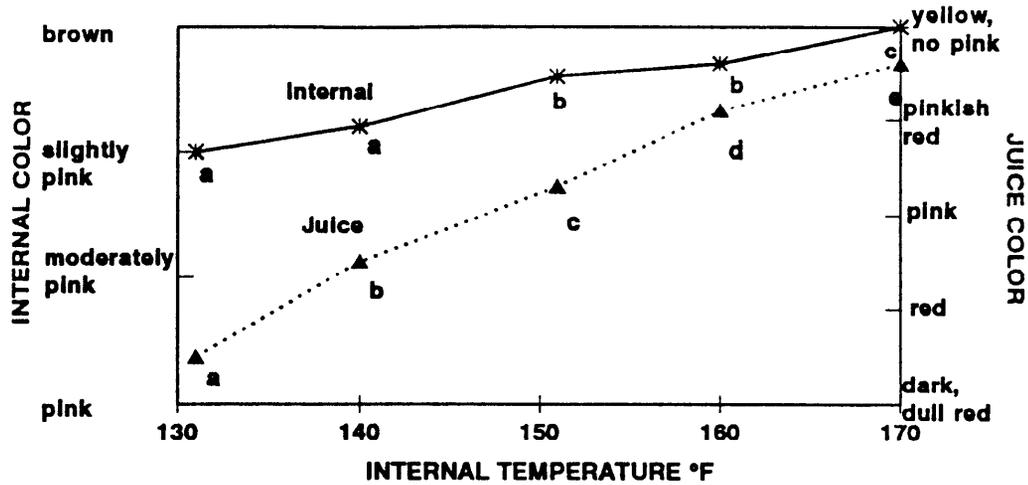


Figure 1. Visual Appraisal of Internal Color and Expressible Juice Color of Ground Beef Patties Cooked to Five Internal Temperatures. Within a Trait, Internal Temperatures without a Common Superscript Letter Are Different ( $P < .05$ ).

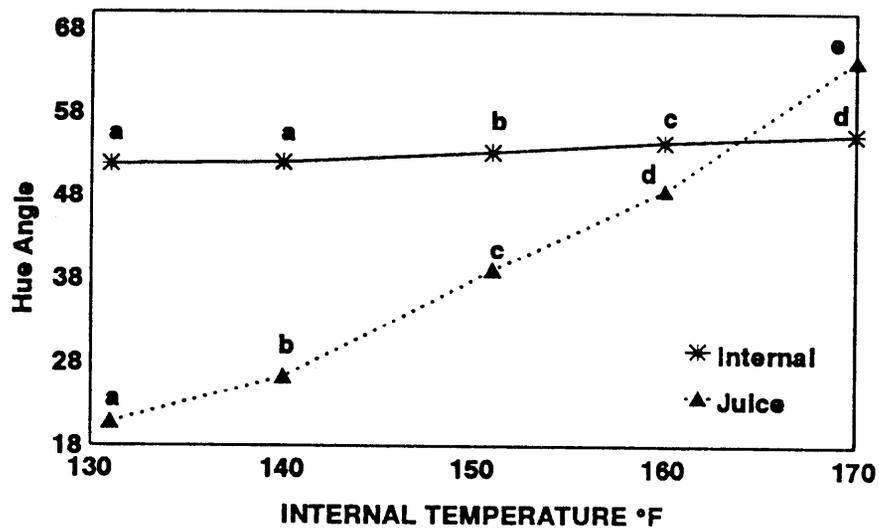


Figure 2. Instrumental Measure of Redness, for Internal Color and Expressible Juice Color of Ground Beef Patties Cooked to Five Internal Temperatures. The Larger the Number, the Less Red the Color. Within a Trait, Internal Temperatures without a Common Superscript Letter Are Different ( $P < .05$ ).