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COOKING PROPERTIES OF BEEF LOIN STEAKS USED TO DEVELOP NEW DEGREE OF DONENESS COLOR GUIDELINES

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Introduction. Degree of doneness of cooked meat (subjective visual color) has traditionally been used by food service and consumers as an information system. The Beef Steak Color Guide for Degrees of Doneness (National Live Stock and Meat Board, 1979) has been a useful tool in providing customer satisfaction regarding degree of doneness. Recently, changes and concerns in the meat industry, such as: food safety, reduced fat content, newer cooking methods and smaller portion sizes have necessitated reevaluation and revisions in degree of doneness guidelines.

Degree of doneness scores for beef loin steaks have not been shown to be affected by variations in broiling procedures (Berry, 1993) or broiling vs roasting (Cross et al., 1979), although Berry and Leddy (1990a) observed a more rare appearance in steaks subjected to faster rather than slower broiling procedures. Unklesbay and Unklesbay (1984) reported under real-time restaurant situations, no relationship existed between specified degree of doneness and broiling times. Customer satisfaction was strictly based on the performance of the cook. The objective of this study was to develop new cooked degree of doneness pictures for beef steaks. The new pictorial standards will be displayed at the 41st International Congress of Meat Science and Technology. This paper presents cooking properties of steaks used in the color photography as influenced by USDA Quality Grade, cooking method and endpoint temperature.

Methods. Nine beef loins representing USDA Choice (Small degree of marbling) and nine loins from USDA Select (Slight degree of marbling) were used in the study. Frozen strip loins were processed into 2.54 cm thick steaks using a band saw. Two cooking procedures were used in this study. The first procedure involved broiling on an electric open hearth broiler (Farberware Model 350A, Walter Kidde and Co., Bronx, NY). Temperatures at the surface of the broiling rack during cooking ranged from 170 to 200°C. The second cooking procedure consisted of broiling within an oven broiler (Farberware convection/broil oven, Model T-4850, Walter Kidde and Co., Bronx, NY). Temperature cycling within the oven ranged from 245 to 315°C. Steaks were cooked by both procedures to one of 11 endpoint temperatures (130, 135, 140, 145, 150, 155, 160, 165, 170, 175, 180°F). Steaks from a particular loin were distributed across as many endpoint temperatures as possible within a cooking method.

Steaks were thawed at 2°C for 24 h before cooking. All external fat was removed from steaks prior to weighing. Temperatures were monitored in the center of steaks during cooking with iron constantan thermocouples. When steaks reached their endpoint temperature, they were removed from the heat source, blotted and weighed. Steaks were cut longitudinally down the middle and a 7.6 cm long section was removed for photography. Cooking yields, cooking times and visual degree of doneness (Beef Steak Color Guide for Degree of Doneness, National Live Stock and Meat Board) were measured.

Results and Discussion. Regardless of the three factors involved in the design, confidence intervals (95%) for degree of doneness score were quite consistent, being generally slightly <2.0 units on the degree of doneness scale. However, this does imply, that even under the rigid cooking conditions employed in this study, there is a strong possibility of obtaining one degree of doneness higher or lower than the degree of doneness anticipated. The degree of doneness codes are listed in Table 1 at the endpoint temperature suggested for their occurrence in the Beef Steak Color Guides (National Live Stock and Meat Board, 1979). Results from this study would indicate that regardless of grade and cooking method, those endpoint temperatures generally provide the degree of doneness originally anticipated to occur when the color guides were developed. In the present studies, steaks cooked in the oven broiler possessed a broader band of consistent color and thus, their pictures were used more extensively in selecting new degree of doneness guides.

Cooking method exerted a major influence on cooking time as evidenced by the regression of cooking time on endpoint temperature (Table 2). As might be expected, the higher temperature in the oven broiler compared to that on the broiler rack surface of the open hearth broiler helped expedite cooking times. An interaction ($P < .003$) of grade and cooking method was observed for mean cooking yield values at 155°F (Table 3). Choice grade steaks cooked on the open hearth broiler had higher cooking yields than those cooked in the oven broiler, while the opposite results occurred for Select steaks. The slope (*b*) did not reflect this finding since the high cooking yields noted for Select grade steaks cooked by oven broiling to 155°F and lower temperatures was not found at the higher temperatures.

Conclusions. Regardless of grade and cooking method, considerable variation can exist in degree of doneness of cooked beef steaks over a wide range in final endpoint temperature. However, the use of considerably different cooking temperatures (subsequently, different cooking times) does not appear to create differences or greater variation in degree of doneness. Nevertheless, the employment of the higher temperature oven broiler resulted in steaks exhibiting a broader band of more consistent cooked color. Results from this study would imply that the generally recognized endpoint temperatures for the various degrees of doneness are basically correct, even for lean steaks with no external fat.

Literature.

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Table 1. Confidence intervals (95%) for degree of doneness according to endpoint temperature, grade and cooking method

Endpoint temperature °F (°C)	Degree of doneness codes[a]	Choice		Select	
		Open hearth broiler	Oven broiler	Open hearth broiler	Oven broiler
130 (54.4)	Very rare = 6	5.0-6.0	5.2-6.0	5.0-6.0	5.2-6.0
135 (57.2)		5.5-6.0	4.0-6.0	5.0-6.0	5.2-6.0
140 (60.0)	Rare = 5	4.5-6.0	4.0-6.0	4.5-6.0	3.8-5.5
145 (62.8)		4.5-6.0	3.8-5.5	3.9-5.5	3.5-5.2
150 (65.6)	Medium rare = 4	3.5-5.5	2.8-4.5	3.8-5.5	3.5-5.0
155 (68.4)		3.8-5.2	2.5-4.2	3.0-5.5	3.0-4.5
160 (71.1)	Medium = 3	2.3-4.0	3.0-4.5	3.3-4.7	2.2-3.8
165 (73.9)		1.8-3.5	1.8-3.5	1.8-3.5	1.9-3.5
170 (76.7)	Well done = 2	1.5-3.2	1.5-3.2	2.0-4.0	1.0-3.0
175 (79.4)		1.0-3.0	1.0-3.0	2.2-3.9	1.0-3.0
180 (82.2)	Very well done = 1	1.0-3.0	1.0-2.5	1.0-2.5	1.1-2.8

[a]Degrees of doneness according to National Live Stock and Meat Board Beef Steak Color Guide (1979), Names listed at the endpoint temperatures suggested in the Guide.

Table 2. Linear regressions of cooking time on endpoint temperature (°F) adjusting for initial raw steak temperature

Grade	Cooking method	Mean cooking time (min) at endpoint temperature of 155°F and raw steak temperature of 40°F	*b* (slope)
Choice	Open hearth broiler	29 ± .5	.41 ± .04
Choice	Oven broiler	20 ± .5	.25 ± .03
Select	Open hearth broiler	29 ± .5	.45 ± .03
Select	Oven broiler	18 ± .5	.19 ± .03
Significance, P <:			
	Grade	.989	.865
	Cooking method	<.001	<.001
	Grade x cooking method	.206	.135

Table 3. Linear regressions of cooking yield on endpoint temperature (°F)

Grade	Cooking method	Mean cooking yield (%) at endpoint temperature of 155°F	*b* (slope)
Choice	Open hearth broiler	76 ± .5	-.38 ± .03
Choice	Oven broiler	74 ± .5	-.35 ± .03
Select	Open hearth broiler	73 ± .5	-.36 ± .03
Select	Oven broiler	75 ± .5	-.28 ± .03
Significance, P <:			
	Grade	.064	.152
	Cooking method	.454	.061
	Grade x cooking method	.003	.424