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## Abstract

Subprimals can be stored in a vacuum package for extended periods of time. The number of days that subprimals may be held before processing can be influenced by the distribution chain, accessibility, and subprimal price fluctuations. Extended vacuum storage before grinding could affect biochemical, oxidative, and microbial properties of these subprimals and influence their color stability. Our objective was to determine the effects of two subprimal types (chuck roll and knuckle), two quality grades (Premium Choice and Select), and three vacuum-packaged storage aging times before processing (7, 21, and 42 days) on ground beef patty display color stability.

## Keywords

Cattlemen's Day, 2014; Kansas Agricultural Experiment Station contribution; no. 14-262-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 1101; Beef Cattle Research, 2014 is known as Cattlemen's Day, 2014; Beef; Ground beef; Vacuum storage; Subprimals; Quality grades

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# Aging Premium Choice Chuck Rolls for Minimal Days Maximizes Color Stability and Extends Retail Display Life

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## Introduction

In retail markets, color stability without discoloration is an economically important trait because it can allow for extended retail sale opportunities, fewer discounts, and reduced product loss. Ground beef is the most commonly consumed beef product in the United States. Historically, the source of ground beef comes from lower quality cuts, trimmings from subprimals, and subprimals from cull cows; however, alternative grinds from whole and/or premium quality subprimals are becoming more popular with consumers. Subprimals from the chuck and round are logical subprimals that could be used for premium ground beef production because they cost less than other subprimals such as those from the rib and loin. Ground beef products from higher quality grades such as Premium Choice (upper two-thirds of Choice) offer merchandising potential and are commonly utilized as a higher quality product. The inherent lean and fat property differences that may exist in these subprimals could potentially influence the color display stability of the resulting ground beef products.

Subprimals can be stored in a vacuum package for extended periods of time. The number of days that subprimals may be held before processing can be influenced by the distribution chain, accessibility, and subprimal price fluctuations. Extended vacuum storage before grinding could affect biochemical, oxidative, and microbial properties of these subprimals and influence their color stability. Our objective was to determine the effects of two subprimal types (chuck roll and knuckle), two quality grades (Premium Choice and Select), and three vacuum-packaged storage aging times before processing (7, 21, and 42 days) on ground beef patty display color stability.

## Experimental Procedures

At the end of each aging time (7, 21, or 42 days), four knuckles or two chuck rolls representing their respective quality grade categories (upper two-thirds of Choice and Select), were combined and ground using a 3/8-in. plate to form a treatment or sample batch. Six replications were made for each of the 12 treatment combinations. After the second final grind using a 1/8-in. plate, proximate analysis, myoglobin concentrations, and pH were conducted on raw ground beef samples. For display color, 1/4-lb patties were formed using a Hollymatic patty machine (Hollymatic Corporation, Countryside, IL), packaged in polyvinyl chloride-overwrapped trays, and displayed at 36°F in a coffin-type retail case under 150-foot candles of continuous fluorescent lighting. Six trained color panelists evaluated patty visual color and discoloration to the nearest 0.5 using 8-point scales, with 1 = extremely bright cherry-red, 2 = bright cherry-red, 3 = moderately bright cherry-red, 4 = slightly bright cherry-red, 5 = slightly dark cherry-red, 6 = moderately dark red, 7 = dark red, and 8 = extremely dark red for visual color; and 1 = very bright red, 2 = bright red, 3 = dull red, 4 = slightly dark red, 5 = moderately dark

red, 6 = dark red to tannish red, 7 = dark reddish tan, and 8 = tan to brown for visual discoloration. Ground beef patties were evaluated at 0, 24, 48, and 72 hours of display by the trained color panelists, and a HunterLab MiniScan (Reston, VA) was used to evaluate instrumental color. At the beginning of display, ground beef patties were evaluated for microbial (aerobic plate count) and lipid oxidation (thiobarbituric acid reactive substances, or TBARS) properties.

## Results and Discussion

Ground beef pH values were similar ( $P > 0.05$ ) for subprimal type and quality grade; however, myoglobin concentration was greater ( $P < 0.05$ ) for knuckle than chuck roll subprimals (Table 1). Ground beef patties from knuckle and Select subprimals had higher ( $P < 0.05$ ) percentages of moisture and protein but lower percentages of fat than those from chuck roll and Premium Choice subprimals, respectively.

Ground beef patties from Premium Choice subprimals had ( $P < 0.05$ ) 0.5 lower visual color scores (brighter red) and 0.7 lower discoloration scores (less discoloration) than those from Select subprimals. A subprimal type  $\times$  aging time  $\times$  display time interaction ( $P < 0.05$ ) was observed for visual color (Figure 1) and discoloration (Figure 2). For visual color and discoloration, all subprimal type  $\times$  aging time treatments increased linearly (i.e., became darker red and more discolored) over display time ( $P < 0.05$ ). For all aging time  $\times$  display time means, patties from chuck roll subprimals had ( $P < 0.05$ ) brighter red and less discolored visual scores than those from knuckle subprimals; however, the largest differences due to aging time were observed for patties from chuck roll subprimals, in which those aged 42 days had ( $P < 0.05$ ) much darker and more discolored scores at 48 and 72 hours of display than those aged for 7 and 21 days. Instrumental color measures supported the visual observations, with ground beef patties from chuck roll and Premium Choice having lighter (higher  $L^*$ ), redder (higher  $a^*$ ), yellower (higher  $b^*$ ), and greater intensity (higher chroma) color than those from knuckle and Select subprimals, respectively. During hours of display, patties initially (0 hour) had higher  $L^*$  values than at the remaining display times (24, 48, and 72 hours) and  $a^*$ ,  $b^*$ , and chroma decreased, indicating a decline in redness, yellowness, and color intensity with increased hours of display.

If a visual and discoloration score of 5 was set as the threshold of consumer acceptability, patties from chuck roll subprimals aged 7 and 21 days would have 48 more hours of color shelf life than patties from knuckle subprimals from all aging times (which passed this threshold prior to 24 hours of display) and 24 more hours of color shelf life than patties from chuck roll subprimals aged 42 days (which passed this threshold at 48 hours of display). The accelerated discoloration could lead to less opportunity for sale and an earlier potential for discounting/discarding of the patties.

At the beginning of display, patties from knuckle subprimals had higher ( $P < 0.05$ ) aerobic plate counts (colony-forming units per gram) than those from chuck roll subprimals (Table 2). As days of aging increased, plate counts also increased ( $P < 0.05$ ). In addition, patties from subprimals aged 7 days had ( $P < 0.05$ ) less lipid oxidation (lower TBARS) than those aged 21 and 42 days. This result suggests that fewer days of aging would result in ground beef patties with lower initial microbial levels and less lipid oxidation at the initiation of display.

## Implications

Premium Choice chuck rolls aged for fewer than 21 days are recommended to maximize color stability and extend display life; patties from knuckle subprimals should be displayed for a minimal time because color deteriorates rapidly, especially with extended aging times.

**Table 1. Subprimal type × quality grade interaction means for percentages of moisture, fat, and protein; myoglobin concentration; and pH of ground beef patties**

Trait	Chuck roll		Knuckle		SE
	Premium Choice	Select	Premium Choice	Select	
pH	5.84	5.82	5.83	5.82	0.045
Myoglobin, mg/g <sup>1</sup>	6.27	5.81	6.53	6.63	0.181
Moisture, %	62.2 <sup>a</sup>	66.5 <sup>b</sup>	70.7 <sup>c</sup>	72.7 <sup>d</sup>	0.31
Fat, %	19.8 <sup>a</sup>	14.3 <sup>b</sup>	8.5 <sup>c</sup>	5.8 <sup>d</sup>	0.42
Protein, % <sup>2</sup>	17.5	18.5	19.3	20.0	0.16

<sup>1</sup> Myoglobin concentration = mg/g meat; main effect ( $P > 0.05$ ) in which knuckle > chuck roll.

<sup>2</sup> Main effect ( $P > 0.05$ ) in which knuckle > chuck roll.

<sup>a-d</sup> Means within a row with a different superscript letter differ ( $P < 0.05$ ).

**Table 2. Effects of subprimal type, quality grade, and aging time on aerobic plate count (APC) and lipid oxidation (TBARS) of ground beef patties**

Trait	Subprimal type <sup>1</sup>		SE	Quality grade <sup>2</sup>		SE	Days of aging			SE
	CR	KN		PCH	SEL		7 days	21 days	42 days	
APC <sup>3</sup>	4.2 <sup>a</sup>	4.6 <sup>b</sup>	0.12	4.3	4.5	0.12	2.9 <sup>a</sup>	3.9 <sup>b</sup>	6.4 <sup>c</sup>	0.13
TBARS <sup>4</sup>	0.46	0.54	0.03	0.48	0.51	0.03	0.27 <sup>a</sup>	0.58 <sup>b</sup>	0.65 <sup>b</sup>	0.03

<sup>1</sup> Subprimal type: CR = chuck roll; KN = knuckle.

<sup>2</sup> Quality grade: PCH = Premium Choice; SEL = Select.

<sup>3</sup> APC (log colony-forming units per gram [CFU/g] or log CFU/cm<sup>2</sup>).

<sup>4</sup> Thiobarbituric acid reactive substances (mg malonaldehyde/kg).

<sup>a-c</sup> Means within a row and main effect with a different superscript letter differ ( $P < 0.05$ ).

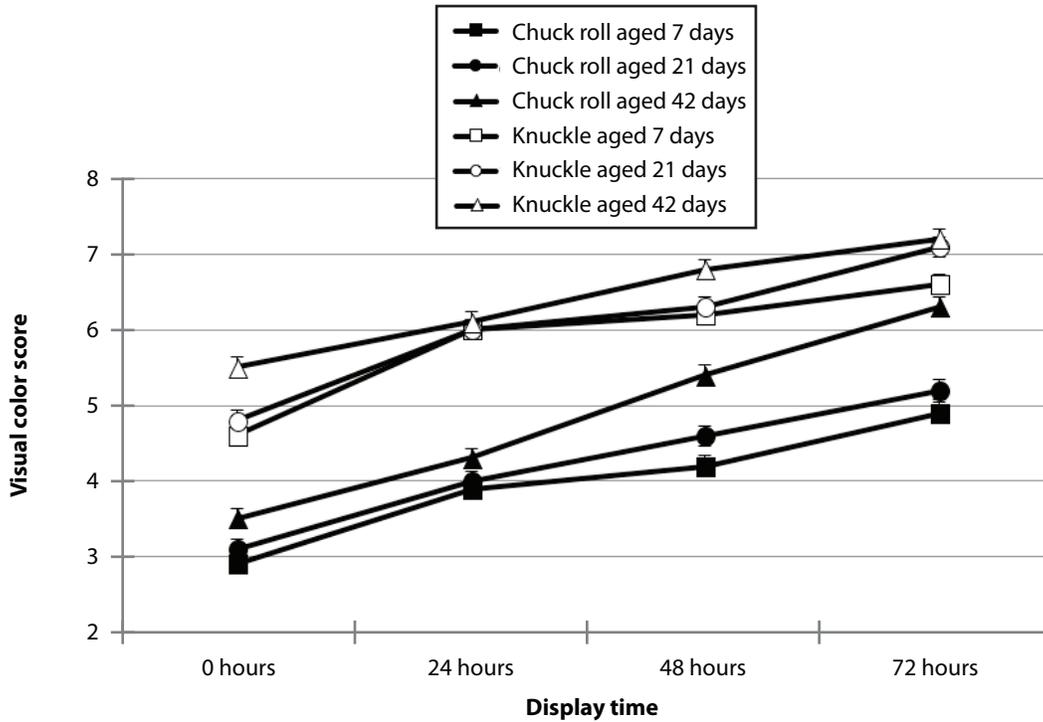


Figure 1. Subprimal type × aging time × display time interaction means for visual color scores (2 = Bright cherry-red; 5 = Slightly dark cherry-red; 8 = Extremely dark red) of ground beef patties (SE = 0.13).

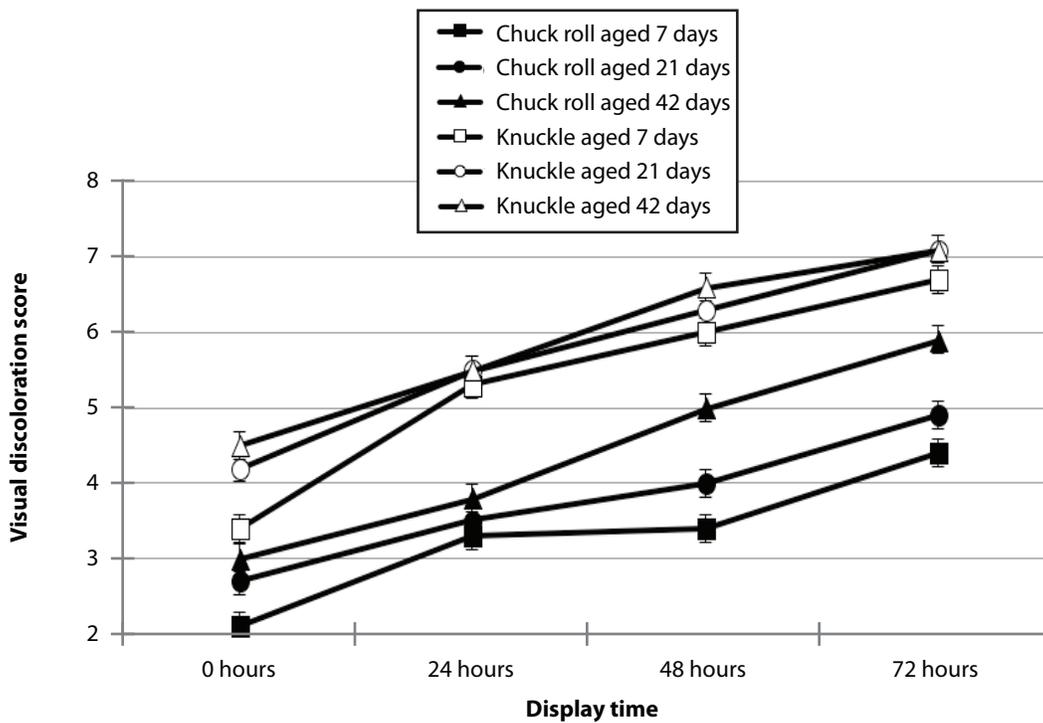


Figure 2. Subprimal type × aging time × display time interaction means for visual color discoloration scores (2 = Bright red; 5 = Moderately dark red; 8 = Tan to brown) of ground beef patties (SE = 0.18).