Meat Science 106 (2015) 50–54

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Beef muscle isolation has no detrimental effect on premium ground beef programs

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ARTICLE INFO

Article history:
Received 9 June 2014
Received in revised form 9 January 2015
Accepted 26 March 2015
Available online 3 April 2015

Keywords:
Ground beef
Meat color
Oxidation
Beef chuck muscle

ABSTRACT

This experiment evaluated whether isolating certain muscles from the chuck for retail sale and excluding them from ground beef mix changes the number of days that ground chuck is acceptable to consumers. Chucks were harvested from twenty-four beef steers, and were allocated to either traditional or innovative fabrication methods. Resulting ground beef patties were stored in retail simulation conditions for 7 days to determine color and oxidative stability. Raw patties were analyzed for thiobarbituric acid reactive substances (TBARS), oxymyoglobin concentration, objective color by Minolta Chromameter, and by a trained sensory panel for odor, color and percent discoloration. No differences ($P > 0.05$) were observed between traditional and innovative style patties for TBARS, sensory odor or color, or oxymyoglobin concentration. Minolta Chromameter readings revealed more substantial fading ($P < 0.05$) in traditional patties compared with innovative style patties. This study demonstrated that removing certain muscles from the ground chuck mix does not cause detrimental consequences in resulting ground chuck patties.

1. Introduction

From 1993 to 1998, the price of chucks and rounds decreased 25–26%, prompting research to find new ways to market these "underutilized" cuts (Von Seggern, Calkins, Johnson, Brickler, & Gwartney, 2005). The success of the Beef Muscle Profiling Project led processors to isolate muscles from the chuck for individual sale and gain an approximate US $50 to $70/head in market value (Von Seggern et al., 2005). One of the consequences of this practice was the decrease in ground chuck available for "premium grinds" which are specialty blends that can be differentiated based on flavor, texture, nutrition, and/or management claims. Examples of this include subprimal specific and USDA quality grade grinds such as brisket grinds for specific fatty acid composition or Prime burgers.

Ground beef is the largest percentage of all beef items consumed at home or sold into foodservice (Lundeen, 2011). Approximately 42% of beef is consumed as ground beef (Davis & Lin, 2005). Fourteen percent of linear footspace in self service retail meat cases was devoted to ground beef in 2010, up from 12% in 2008 (National Meat Case Study, 2010). Additionally, whole muscle beef cuts commanded 28% of footspace in 2010, down from 30% in 2004 (National Meat Case Study, 2010). This increase in demand for ground beef was a result of the poor economic situation, which caused many consumers to "trade down" from higher priced steaks and roasts to lower cost items, such as ground beef (McCarty, 2011). Due to the change in consumer purchasing patterns, the price of ground beef increased in comparison to whole muscle beef cuts. In May 2011, the price of steak had increased by 6.3% and ground beef by 13.6% in comparison to May 2010 (McCarty, 2011).

In addition, differences exist in functional characteristics, such as color, heme-iron content and pH, between the most popular chuck muscles being utilized as steaks (Von Seggern et al., 2005). Using muscles with different color stabilities in ground beef can dramatically affect shelf life as determined by discoloration and oxidation (Raines, Hunt, & Unruh, 2010). At the point of sale, meat color is the most important factor in determining quality (Troy & Kerry, 2010); therefore, a change in the rate of discoloration can greatly impact consumer-purchasing decisions. Nearly 15% of retail beef is discounted in price before it can be sold due to surface discoloration, leading to annual revenue losses in the meat industry totaling approximately US $1 billion (Smith, Belk, Sofos, Tatum, & Williams, 2000). Therefore, meat retailers may be interested in the impact of excluding muscles on the days of viable shelf life of the resulting ground beef.

The objective of this study was to determine the impact of removing high value muscles from ground chuck on the overall odor and color stability of ground chuck at four different retail storage time periods.

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http://dx.doi.org/10.1016/j.meatsci.2015.03.022
0309-1740/

2. Materials and methods

2.1. Ground beef manufacture

Twenty-four beef steers were slaughtered at the University of Missouri-Columbia in groups of six. Beef carcasses were chilled for 48 h postmortem and right chucks were assigned to a traditional method (TRA) and left chucks to an innovative method (INN). TRA included trim from the neck and shank, half of the clod (IMPS 114) and half of the chuck roll (IMPS 116A; USDA, 2010). INN included trim from the neck and shank, half of the clod heart (IMPS 114E), half of the chuck eye roll (IMPS 116D), and excluded the *infraspinatus* (IMPS 114D), *supraspinatus* (IMPS 116B), *teres major* (IMPS 114F) and *serratus ventralis* (IMPS 116G; USDA, 2010). The resulting sample was first ground through a 10 mm plate and then through a 4.5 mm plate using a LEM #8 .35 HP Grinder (LEM Products, West Chester, OH, USA). Each patty was approximately 113 g and 0.95 cm thick and was hand pressed using a LEM Professional Burger Press (LEM Products, West Chester, OH, USA). During fabrication, muscle and ground beef weights were collected to determine meat loss during processing. Resulting ground beef patties were placed on Styrofoam® trays, overwrapped with commercially available polyvinyl chloride (PVC) and displayed under fluorescent lights with a light intensity of 1770 lx at approximately 4 °C for up to 7 days following fabrication to determine color and oxidative stability.

2.2. Fat determination

Fat percentage determination, using the CEM procedure (CEM SMART Trac system, Matthews, NC, USA), described in Dow, Wiegand, Ellersieck, and Lorenzen (2011) was conducted in triplicate. Briefly, 3.75–4.5 g of sample was dried in between two pads, wrapped in TRAC paper, and packed into the bottom of the CEM TRAC tube. Fat percentage was determined on a dry weight basis using nuclear magnetic resonance and converted to a wet weight basis.

2.3. Oxymyoglobin concentration determination

Oxymyoglobin concentration was determined on days 1, 3, 5 and 7. Briefly, 15 g sample was ground in a Waring blender with approximately 50 mL of liquid nitrogen until the sample was completely pulverized. Three grams of powdered sample were placed back in the blender with 30 mL myoglobin buffer (40 mM KH_2PO_4) and the mixture was blended until homogenous. The sample was placed in centrifuge bottles and incubated at 4 °C for 1 h. Bottles were centrifuged at 15,000 rpm for 30 min. The sample was filtered and transferred into a cuvette and placed into the spectrophotometer and was read at 418 nm. Oxymyoglobin values were calculated using the following equation and expressed as mg of myoglobin per g of sample: $(((Abs_{418}/\epsilon) * 16{,}946) * (0.03 * 1000))/g$ of sample; where $\epsilon = 128{,}000$ for oxymyoglobin, 16,946 is the molar concentration of myoglobin for bovine, and 0.03 is g/L of myoglobin* the number of L of buffer added.

2.4. Sensory panel

Approval from the University of Missouri Institutional Review Board was granted for this study. Eight, trained sensory panelists evaluated patty color, percent discoloration and patty odor on days 1, 3, 5 and 7 using the methods described by Rhee, Krahl, Lucia, and Acuff (1997). Briefly, patties were placed in 15.24 cm diameter, glass petri dishes for 30 min. before sensory evaluation at room temperature (21 °C). Plastic watch glasses were placed on each glass dish to trap the odor volatiles. Two minutes was timed between panelists to allow for the re-accumulation of volatiles. Panelists briefly lifted the watch glasses to sniff the patties and immediately recorded the off-odors detected. Off-odor descriptors included 'putrid', 'sour' and 'fruity', and each descriptor had an 8-point intensity scale (0 = no off odor, 7 = extreme off odor; Rhee et al., 1997), with references of strawberry yogurt for a 'fruity' off-odor with an intensity of six and buttermilk for 'sour' off-odor with an intensity of four (Rhee et al., 1997). Additionally, intensity markers were available to panelists at each evaluation, with 8 vials of increasing concentration of vanilla to water (0–100% water, 0% vanilla and 7–0% water, 100% vanilla). Following odor analysis, the watch glasses were removed and the patties were placed under a MacBeth lighting apparatus (Model EBX-22; 60W Incandescent bulb; Kollmorgen Corporation, Newburgh, New York, USA). Panelists evaluated percent discoloration based on an 8-point scale (0 = no discoloration, 1 = 1–12.5% discoloration, 8 = complete discoloration; Montgomery, Parrish, Olson, Dickson, & Niebuhr, 2003). Panelists also evaluated lean color of the patties under the MacBeth using a predetermined scale as described by Montgomery et al. (2003), where 1 = dark brownish-greenish gray, 2 = light brownish-greenish gray, 3 = light gray, 4 = moderately dark red, 5 = slightly dark red, 6 = cherry red, 7 = moderately light cherry red, and 8 = very light cherry red.

2.5. Objective color determination

External L*, a* and b* color values were measured on raw patties on days 1, 3, 5 and 7 immediately before sensory panel evaluation using a Minolta Chromameter (Model CR-410, Minolta Camera Co., Ltd., Osaka, Japan; 5 cm aperture, illuminant C). Three readings were collected for each patty and averaged to account for variation in the sample. The Minolta was calibrated using polyvinyl chloride placed on a white calibration plate each day.

2.6. Determination of lipid oxidation

Patties were pulled on days 2 and 6 after fabrication to determine the degree of lipid oxidation using the thiobarbituric acid reactive substances (TBARS) extraction method, described by Pegg (2001). Briefly, 5 g of ground meat, 2.5 mL antioxidant solution, 50 mL TCA reagent and 50 mL distilled water were homogenized. The slurry was filtered, and a 5 mL aliquot was pipetted into a 50 mL centrifuge tube. 5 mL thiobarbituric acid reagent (0.02 M TBA in distilled water) was added to the solution and the tube was capped and vortexed for 3 s. The tubes were placed in a boiling water bath for 35 min, removed, and placed promptly in ice for 5 min. The sample was transferred into a cuvette and absorbance was read at 532 nm using a spectrophotometer.

2.7. Statistical analysis

The study was a randomized complete block design with carcass as the random effect in the model. Statistical analyses were performed using the PROC CORR and MIXED procedure of SAS (Version 9.2, SAS Inst., Cary, NC, USA) with fat percentage as a covariate. $P < 0.05$ was used to determine significance for meat characteristics. The model included the fixed effects of treatment and all relevant interactions. None of the interactions were significant ($P < 0.05$); therefore, only main effects were reported.

3. Results and discussion

3.1. Fat content

No differences in fat content were found between treatments ($P > 0.05$). The mean fat percentage for traditional patties was 17.7% and 17.3% for innovative patties (data not presented in tabular form). The similarity in means between treatments was expected because all intermuscular fat was excluded from the grinds, leaving only intramuscular fat contributing to fat percentage. Fat percentage was used as a covariate in all statistical analyses because it is known to affect visual appearance and potentially fatty acid composition.