Incorporation of lean finely textured beef improved select quality characteristics of ground beef patties

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Story in Brief

Lean finely textured beef (LFTB), commonly used with ground beef to yield a lower fat, lower cost product, is created from fatty trimmings (greater than 80% fat), centrifuged to remove the fat, leaving a product that is 94% to 97% lean. The objective of this study was to determine the effects of LFTB on fresh and cooked quality characteristics of ground beef patties. Ground beef was formulated into 6 treatments in a 2 × 3 factorial of 82% or 93% lean and 0%, 10%, or 20% LFTB. Batches of each treatment combination (n = 5) were ground through a 3/8-in plate and formed into 1/3-lb patties, then overwrapped with a PVC film and placed in simulated retail display for 5 d. Instrumental color was measured daily, whereas lipid oxidation was measured on patties after 0, 1, 2, and 4 d of display. Additional patties were cooked to 160 °F before measuring internal instrumental color, cooked lipid oxidation, cooking loss, and Lee-Kramer shear force. The pH of fresh patties increased ($P < 0.05$) with increasing fat levels and LFTB percentage. Regardless of lean percentage, increasing LFTB in fresh patties resulted in lighter, redder, and less yellow patties ($P < 0.05$) throughout display. Even though lipid oxidation was similar among fresh patties on d 0 of display, oxidation values were lower ($P < 0.05$) with increasing LFTB on d 1, 2, and 4 of display. Cooking loss was lowest ($P < 0.05$) in 20% LFTB patties, whereas shear force declined ($P < 0.05$) with increasing fat levels and increased LFTB; however, LFTB inclusion percentage did not ($P > 0.07$) affect the internal color or oxidation of cooked patties. Overall, LFTB incorporation up to 20% improved the shelf-life of fresh ground beef patties and the tenderness of cooked patties, with no detrimental effects on cooked color.

Introduction

Lean Finely Textured Beef (LFTB) is a commonly used beef product made from high fat trimmings and is between 94% and 97% lean beef. When included in ground beef, it usually comprises 10-15% of the total product. By allowing around 10-lb more lean beef to be recovered from each carcass, LFTB is a way of turning meat and fat excluded from other cuts into a diverse and profitable product. Due to the formation of ammonium hydroxide and subsequent increase in pH during processing, the number of potential pathogens can also be reduced, improving food safety.

The LFTB process begins with the recovery of lean from fatty trim (greater than 80% fat) removed from the carcass during fabrication. It is difficult and economically infeasible to remove the lean from fatty trim by hand. Trim pieces are ground and heated to around 100 °F and the lean is separated using centrifugal force. In the case of Beef Products Incorporated (BPI), the lean beef is treated with a small amount of ammonia gas which combines with moisture in the beef to create ammonium hydroxide. This treatment raises the pH of the beef to reduce potential pathogens. The final step in the process is to rapidly freeze and cut the LFTB into large blocks or small pieces for shipping.

Although LFTB has been widely used in its current form for around twenty years, little research could be found concerning its effects on the quality characteristics of fresh and cooked ground beef. Therefore, the objective of this study was to determine the effects of LFTB on the fresh pH and color stability, as well as cooking loss, cooked color, shear force, and lipid oxidation of ground beef patties.

Materials and Methods

Denuded knuckles (97% lean) and beef trimmings with a 50:50 lean to fat ratio were ground once in a commercial mixer/grinder through a 5/8-in plate, and mixed appropriately to formulate 25-lb batches of either 82% or 93% lean ground beef. Additionally, lean finely textured beef (LFTB) was incorporated at 0%, 10%, and 20%, replacing the appropriate amount of knuckles (6 treatments with 5 batches/treatment). Batches were ground through a 3/8-in plate and 1/3 lb patties formed using a commercial patty forming machine. Patties for cooked Thiobarbituric Acid Reactive Substances (TBARS), cooked color, and Lee-Kramer evaluations were vacuum-packaged and stored frozen.

For display color, patties were packaged in pairs on foam trays and covered with PVC film. They were placed in simulated retail display (34 °F) and randomly shuffled daily to account for any differences within the display case. Measurements of lightness, redness, and yellowness (L*, a*, and b*, respectively) were taken after 0, 1, 2, 3, and 4 d of display. Three scans were taken from each package using a Hunter MiniScanXE (Hunter Associates Laboratory, Inc, Reston, Va.) with a 1- in aperture and illuminant A light source.

Patties for fresh TBARS, a measure of lipid oxidation, were aerobically packaged in individual foam trays and stored in simulated retail display. They were removed from display and frozen after 0, 1, 2, and 4 d display. Patties were thawed before TBARS were assayed.

To determine cooked TBARS, patties were thawed overnight at 34 °F and cooked to 160 °F on countertop electric griddles turning every 2 min, monitored with a handheld thermometer. They were allowed to cool to room temperature then refrozen for storage. Patties were thawed and TBARS assayed as described previously.

Patties for Lee-Kramer shear force were stored, thawed, and cooked similarly to cooked TBARS patties. A 2.4 × 2.4-inch square was cut from the center of each cooked patty, and shear force was measured using an Instron Universal Testing Machine (Instron Worldwide Headquarters, Norwood, Mass.) with a 200-kg load cell and 6 blade Lee-Kramer shear attachment.

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To measure pH, a 1-g sample was removed from each Lee-Kramer patty prior to cooking. This sample was homogenized with 10-mL of distilled water and pH measured using a pH meter.

Patties for cooked color were stored, thawed, and cooked as described previously. Immediately after cooking, these patties were placed in plastic bags and immersed in an ice bath to halt post cooking temperature changes. Each patty was sliced in half parallel to the surface exposing the internal surface, and lightness, redness, and yellowness (L*, a*, and b*, respectively) was measured using a Hunter MiniScanXE with a 1-in aperture and illuminant A light source. These patties were also weighed and measured before and after cooking to calculate cooking loss.

Data were analyzed as a 2 × 3 factorial design with fat level and LFTB level as main effects. The experimental unit was a batch of ground beef with a repeated measure of day for color display analysis. Data were analyzed using the Mixed Models Procedure in SAS (SAS Institute Inc., Cary, N.C.) with least square means separated when $P < 0.05$.

Results and Discussion

In fresh ground beef patties, pH values were greater ($P < 0.0001$) with increasing LFTB inclusion (Table 1). Patties formulated with 82% lean were also shown to have greater pH values ($P = 0.017$). The greater pH of patties containing LFTB was expected due to the presence of ammonium hydroxide, a processing aid known to increase pH values.

Fresh color measurements were affected ($P < 0.05$) by LFTB inclusion (Table 1). Lightness values (L*) increased ($P < 0.0001$) as LFTB increased and were greater ($P < 0.0001$) in 82% lean patties. Patties with 20% LFTB were shown to have greater ($P = 0.055$) a* values (indicating a redder patty) than 0% LFTB patties with 10% LFTB were intermediate. Values for b* (yellowness) decreased ($P = 0.009$) with LFTB inclusion meaning patties were less yellow. These results of an increase in lightness and redness with a decrease in yellowness could be accredited to the greater pH which tends to protect color.

Values for fresh TBARS decreased ($P < 0.0001$) with increasing LFTB indicating these patties were less oxidized (Table 1). Fresh TBARS were not shown to be affected ($P > 0.05$) by fat level. However, fresh TBARS were affected ($P = 0.012$) by an LFTB inclusions × display duration interaction (Fig. 1). The TBARS were similar ($P > 0.05$) across treatments on the day of patty formation and increased (indicating greater lipid oxidation; $P < 0.05$) with each day of display for all patties. This was expected as patties will continue to oxidize throughout display. Patties containing 10% LFTB had lower TBARS values ($P < 0.0001$) than 0% LFTB patties at d 1 and 4, whereas 20% LFTB patties were lower ($P < 0.0001$) than both 0% and 10% LFTB patties on each day of display after day 0. These results indicate that patties containing LFTB oxidize at a slower rate and would have a longer shelf life than patties without LFTB.

No difference in cooking loss was seen between patties with 0% and 10% LFTB inclusion but was lower ($P = 0.01$) in 20% LFTB patties (Table 2). Cooking loss was also lower (P < 0.0001) in 93% than 82% lean patties. No differences ($P > 0.05$) were found in cooked TBARS between 0% LFTB patties and those with LFTB inclusion (Table 2). However, 93% lean patties had lower ($P < 0.0001$) overall TBARS values than 82% lean, meaning they were less oxidized.

No differences ($P > 0.05$) were found in internal cooked color of ground beef patties (Table 2). Inclusion of LFTB did not affect ($P > 0.05$) lightness, redness, or yellowness (L*, a*, or b*). Furthermore, no differences in internal cooked color ($P > 0.05$) were seen between 82% and 93% lean patties. The result of LFTB having no effect on cooked color was unexpected due to the association between the higher pH seen in dark cutters and persistent pinking in cooked beef. Given the results of this study, it does not appear that pH increase due to ammonium hydroxide inclusion has the same effect on persistent pinking.

Lee-Kramer shear force values decreased ($P < 0.0001$) in cooked patties with each increase in LFTB inclusion (Table 2). Since these values are related to texture or tenderness, lower values would be indicative of more tender patties and higher values with tougher patties. Patties of 82% lean also yielded lower ($P < 0.0001$) shear force values than those with 93% lean.

Implications

The results of this study indicate that the inclusion of lean finely textured beef up to 20% could lend many positive quality characteristics to both fresh and cooked ground beef patties. Decreased lipid oxidation along with improved fresh color could result in a product with greater shelf life and more appealing color to consumers. With no negative effects on cooked color or cooking loss and the potential for increased tenderness, lean finely textured beef inclusion is a viable way to produce a desirable product while ensuring more complete utilization of beef carcasses.

Table 1. Quality characteristics of fresh ground beef patties as affected by lean finely textured beef inclusion and lean composition.

	Lean finely textured beef, %				Lean composition, %		
	0	**10**	**20**	**SE**	**82**	**93**	**SE**
pH	5.84^{c}	6.11^{b}	6.49^{a}	0.028	6.19^{a}	6.10^{b}	0.024
Lightness (L*)[1]	45.66^{c}	46.74^{b}	47.71^{a}	0.208	49.06^{a}	44.34^{b}	0.170
Redness (a*)[1]	19.23^{b}	19.78^{ab}	20.12^{a}	0.258	19.95	19.47	0.211
Yellowness (b*)[1]	17.60^{a}	17.17^{b}	16.94^{b}	0.150	17.32	17.16	0.123
TBARS[2]	1.47^{a}	1.25^{b}	1.05^{c}	0.031	1.28	1.23	0.025

[1] L* values measure darkness to lightness (greater L* values indicate a lighter color); a* values are a measure of redness (greater a* values indicate a redder color); and b* values are a measure of yellowness (greater b* values indicate a more yellow color).

[2] 3-thiobarbituric acid reactive substances (mg of maldenaldehyde/kg of tissue).

Within a row and main effect, least squares means lacking a common superscript letter differ ($P < 0.05$).

Table 2. Quality characteristics of cooked ground beef patties as affected by lean finely textured beef inclusion and lean composition.

	Lean finely textured beef, %				Lean composition, %		
	0	**10**	**20**	**SE**	**82**	**93**	**SE**
Cooking Loss (%)	27.90^{a}	27.50^{a}	24.60^{b}	0.008	29.47^{a}	23.87^{b}	0.006
TBARS[1]	0.87	0.91	0.88	0.046	1.05^{a}	0.72^{b}	0.038
Lightness (L*)[2]	56.14	56.23	55.18	0.772	56.53	55.17	0.629
Redness (a*)[2]	15.56	17.06	17.63	0.739	16.19	17.31	0.603
Yellowness (b*)[2]	18.18	18.78	19.02	0.395	18.41	18.91	0.323
Lee-Kramer shear[3]	176.07^{a}	162.05^{b}	134.81^{c}	3.483	143.56^{b}	171.72^{a}	2.850

[1] 3-thiobarbituric acid reactive substances (mg of maldenaldehyde/kg of tissue).

[2] L* values measure darkness to lightness (greater L* values indicate a lighter color); a* values are a measure of redness (greater a* values indicate a redder color); and b* values are a measure of yellowness (greater b* values indicate a more yellow color).

[3] Greater values indicate tougher patties.

Within a row and main effect, least squares means lacking a common superscript letter differ ($P < 0.05$).

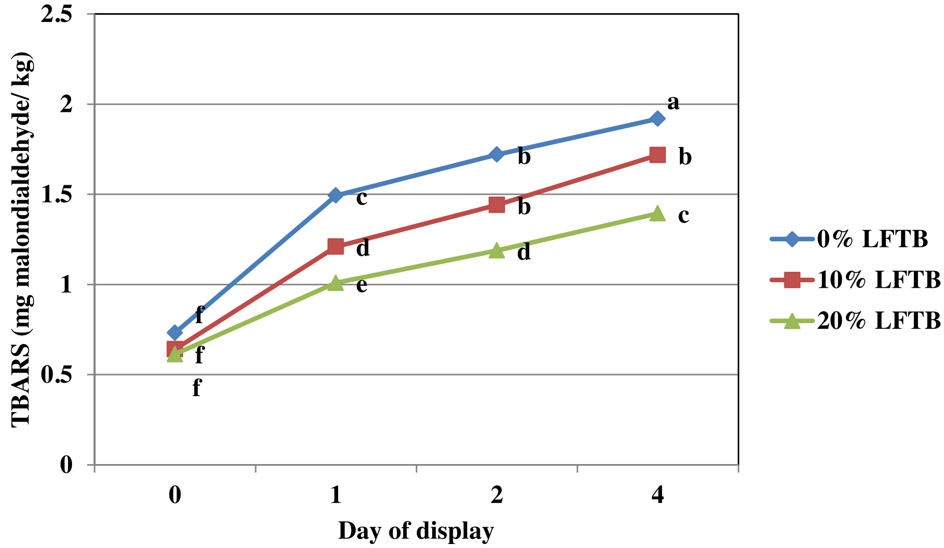

Fig. 1. Interactive effects of day of display and percentage of lean finely textured beef (LFTB) on Thiobarbituric Acid Reactive Substances (TBARS; a measure of oxidation) in fresh ground beef patties. Mean values with different letters differ ($P < 0.05$).