Mechanically Recovered Neck Bone Lean Alters Textural and Sensory Properties of Ground Beef Patties

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Summary

The objective was to characterize ground beef patties manufactured with mechanically recovered neck bone lean (MRNL). Two fat levels (10 and 20%) and four MRNL levels (0, 15, 30 and 45%) were used. Level of MRNL did not affect raw moisture, protein, fat or ash content. Cook yield, water-holding capacity and consumer sensory panel flavor,

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texture or overall desirability were not affected by addition of MRNL. The consumer panel found that juiciness increased in a linear fashion as MRNL level increased. Force necessary to shear a ground beef patty decreased with increasing levels of MRNL. Ground beef patty springiness, hardness and chewiness decreased in a linear fashion as MRNL increased. Patties made with 10% fat were less juicy , harder, and chewier than those with 20% fat. Mechanically recovered lean levels of as little as 15% in low-fat patties (10%) are sufficient to mimic sensory texture and juiciness of 20% fat patties.

Introduction

Beef neck bones are one part of a carcass that can yield a substantial quantity of lean trim. Typically, neck bones are trimmed by hand. This is a labor intensive process that can lead to high levels of ergonomic stress if performed for an extended period of time. This process can also be inefficient, leaving salvageable lean on the bone.

Mechanical systems that recover lean tissue from beef cervical vertebrae portions have been introduced. These systems allow rapid, efficient recovery of lean tissue by hydraulic pressure with minimal bone breakage, temperature rise or increase in calcium content. Lean tissue is pressed away from the bone, leaving the bone mass intact. The final product from this process is finely textured and similar to finely ground beef product (approximately .05 inch diameter). Lean tissue recovered in this fashion has altered functional properties such as increased pH, metmyoglobin reducing ability, water-holding capacity and pigment content.

Sensory and physical differences of processed products containing mechanically deboned meat from older recovery systems have been shown. The objectives of this study were to determine the effects of MRNL on physical, chemical and sensory properties of 10 and 20% fat ground beef patties.

Procedure

Lean and fat beef trim from USDA Select and Standard carcasses was obtained from the University of Nebraska Loeffel Meat Laboratory. All trim was coarse ground, vacuum packaged and frozen in an air blast freezer at -40°F for 14 days. Fresh beef neck bones were sawed to conform to a Protecon PAD 400 automatic trimmer. Pressed lean from the Protecon PAD 400 trimmer was processed through a Baader Lean Separator. The Baader processes the intermediate material between a specially designed neoprene belt and a drum-screen configuration that is effective in removing sinews, tendons, connective tissue and significant bone chips. Mechanically recovered lean was frozen at -40°F.

Grab samples of all raw materials were taken for fat determination by ether extraction. All raw materials were tempered 24 h at 35°F. Lean and fat beef trim and MRNL were combined in the appropriate ratios to yield the following treatments: 10% fat/0% MRNL, 10% fat/15% MRNL, 10% fat/30% MRNL, 10% fat/45% MRNL, 20% fat/0% MRNL, 20% fat/15% MRNL, 20% fat/30% MRNL, 20% fat/45% MRNL. Each 25 lb formulation was mixed five minutes and ground through a 0.19 inch plate. Quarter pound patties were formed with a Hollymatic patty machine. Each patty was separated with double wax paper interleaving. Patties were double bagged in polyethylene, eight patties to a bag, and frozen in an air blast freezer at -40°F until further analyses.

Chemical analysis included moisture, protein, fat and ash content and water-holding capacity by a filter paper press method and reported as percentage expressible moisture. Frozen patties were cooked on an electric grill to an internal temperature ranging from 160 to 170°F. A consumer sensory panel evaluation was conducted. Panelists were asked to evaluate juiciness, texture, flavor and overall desirability for each replication. Cooking measurements included cook yield, and percentage change of diameter and thickness. Comprehensive texture analysis was completed using a Kramer-Shear cell attached to an Instron to determine total energy and peak force and a compression attachment to determine hardness, cohesiveness, springiness and chewiness.

Results

No significant differences were observed among raw patties made with all levels of MRNL for protein, moisture, fat and ash (Table 1). This shows that MRNL can be added to ground beef patties up to 45% without significantly altering basic composition. Of particular interest is the observation that ash content was not different among MRNL levels. Lean recovered from systems that grind bones before lean retrieval normally causes elevated ash levels in the final processed meat to which it is added. This elevation was not seen with this current system of lean retrieval.

No significant differences were observed among cooked patties made with all levels of MRNL for moisture,

Table 1. Raw and cooked proximate composition of ground beef patties manufactured with mechanically recovered neck bone lean (MRNL).

		Fat Level		MRNL Level			
		10%	20%	0%	15%	30%	45%
Raw							
Moisture	(%)	69.72[a]	63.22[b]	65.89	66.48	66.00	67.32
Fat	(%)	10.10[a]	18.88[b]	14.49	14.49	15.02	13.66
Protein	(%)	20.76[a]	18.49[b]	20.28	19.47	19.53	19.22
Ash	(%)	.93[a]	.84[b]	.89	.91	.90	.84
Cooked							
Moisture	(%)	58.59[a]	54.28[b]	56.58	57.27	54.93	56.96
Fat	(%)	13.44[a]	18.78[b]	14.78	15.60	18.11	15.96
Protein	(%)	28.39	26.97	29.53[a]	27.48[b]	27.09[b]	27.21[b]
Ash	(%)	1.47	1.37	1.50	1.42	1.32	1.44

[ab]Means on the same line, within a main effect, with different superscripts are different ($P<.05$)

Table 2. Cooking measurements, water-holding capacity and consumer sensory juiciness of ground beef patties manufactured with mechanically recovered neck bone lean (MRNL).

	Fat Level		MRNL Level			
	10%	20%	0%	15%	30%	45%
Cook Yield (%)	70.27[a]	67.60[b]	68.10	69.61	68.80	69.23
Raw Water-holding Capacity[c]	37.73[a]	33.58[b]	37.09	36.37	35.50	33.66
Cooked Water-holding Capacity[c]	55.10[a]	49.81[b]	53.71	54.34	48.79	3.00
Juiciness[d]	5.06[a]	5.38[b]	4.92	5.04	5.35	5.59

[ab]Means in a row, within main effect, with different superscripts are different (P<.05).
[c] Reported as percent expressible moisture.
[d] Juiciness: 8=extremely desirable, 1=extremely undesirable

Table 3. Instrumental measurements of ground beef patties manufactured with mechanically recovered neck bone lean (MRNL).

	Fat Level		MRNL Level				
	10%	20%	0%	15%	30%	45%	Effect[c]
Kramer Shear							
Peak Force (Newtons/g)	37.16[a]	32.48[b]	45.80	33.70	32.74	27.05	L
Total Energy (Joules/g)	.42[a]	.38[b]	.52	.38	.38	.31	L
Compression							
Springiness (mm)	23.00[a]	21.81[b]	24.75	22.46	21.54	20.88	L
Cohesiveness (Unitless)	.58[a]	.52[b]	.58[a]	.55[ab]	.53[b]	.53[b]	—
Hardness (Newtons/g)	77.83[a]	62.47[b]	85.39	72.76	65.11	57.35	L
Chewiness (Joules/g)	1.06[a]	.72[b]	1.24	.91	.75	.65	L

[ab] Means in a row, within a main effect, with different superscripts are different (P<.05).
[c] L=linear effect, (P<.01).

fat and ash. Patties made with 15%, 30% and 45% MRNL had less (P<.05) protein than patties with 0% MRNL. Raw and cooked patties made with 10% fat had higher (P<.05) moisture and lower (P<.05) fat content than patties made with 20% fat. There were no significant differences in ash or protein content between cooked patties with 10% and 20% fat.

Raw ground beef patties made with 10% fat had lower water-holding capacity than those made with 20% fat (Table 2). There were no significant differences among raw patties made with all MRNL levels, however, there was a trend that showed water-holding capacity increased as MRNL level increased. Because MRNL had a higher pH than standard trim (6.68 vs 5.80, respectively), it is likely that higher levels of MRNL in ground beef formulations result in slightly higher water-holding capacity. Cooked ground beef patties with 10% fat had lower water-holding capacity than those made with 20% fat (Table 2). There were no significant differences among cooked patties made with all MRNL levels. The slight trend that was noted for increased water-holding capacity due to MRNL addition in raw patties was not seen in cooked patties.

No significant differences were observed for cook yield among patties made with all levels of MRNL (Table 2). Patties made with 10% fat had higher cook yields than patties made with 20% fat. Changes in patty diameter (Table 2) due to cooking were not significantly different among patties made with all levels of MRNL. Patties made with 20% fat decreased more in diameter than 10% fat patties. Patties made with 10% fat and 15, 30 and 45% MRNL decreased 8 to 11% in thickness due to cooking while the 10% fat control decreased over 20% in thickness (Figure 1). In patties with 20% fat, decrease in patty thickness became more severe as MRNL level increased from 0 to 45%.

Patties made with 20% fat showed lower peak force (Table 3) and total energy values than 10% fat patties. Fat reduction in comminuted meat products results in less desirable texture due to significant changes in hardness. Peak force and total energy decreased in a linear fashion as MRNL level was increased. With 15% MRNL added to the 10% fat ground beef formulation, the peak force and total energy values were reduced to levels below those for the 20% fat control. It is possible that MRNL could be used as a texture modifying agent in low-fat ground beef patties. Mechanically recovered lean itself is 16-18% fat.

Ground beef patties with 10% fat showed higher values for springiness, cohesiveness, hardness and chewiness than patties with 20% fat (Table 3). Ground beef patty springiness, hardness and chewiness decreased in a linear fashion as MRNL level increased offsetting some of the common criticisms of low-fat patty texture, such as patty "rubberiness". Patties made with 30% and 45% MRNL were less cohesive than patties with 0% MRNL. There were no differences in cohesiveness (P>.05) among patties that contained 15%, 30% and 45% MRNL. The recovery process for this lean source screens out larger pieces of connective tissue that may be found in conventional ground beef and results in a fine, uniform structure. When MRNL is added to a product that normally has a coarse structure (ground beef), it causes a reduction in hardness that is illustrated

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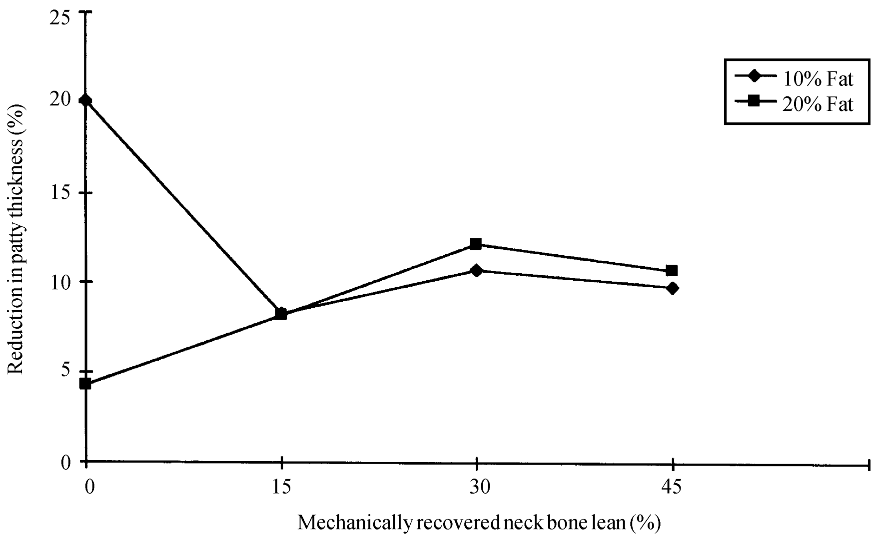

Figure 1. Fat x mechanically recovered beef neckbone lean interactions on reduction in patty thickness due to cooking (P<.05, sem = 3.43).

by the reduction in textural measurements.

Consumer panelists rated 20% fat patties more juicy than 10% fat patties. Juiciness increased in a linear fashion as MRNL level increased. Fat level had no effect on texture, flavor or overall desirability (data not shown). Mechanically recovered neck bone lean also had no significant effect on texture, flavor or overall desirability. Recent advances in mechanical recovery technology have not only changed the recovery process, but also have likely improved the quality of the final product. Modern recovery systems do not grind bones or raise temperatures as severely as previous systems. As a result the final product is of higher quality.

Sensory data does not completely agree with the instrumental texture data. Kramer shear peak force and total energy and compression springiness, hardness and chewiness all decreased as MRNL increased, yet consumer panelists found no differences in texture among MRNL levels. In addition, consumer panelists found ground beef patty juiciness increased as MRNL level increased, yet cook yield and cooked water-holding capacity were not different. Panelists may associate juiciness with a particular attribute of ground beef that was not specifically tested. It is likely that panelists experienced a different texture, but because of the different mouthfeel, they interpreted (and scored) this as a difference in juiciness. These discrepancies are not necessarily downfalls of the research, but merely an indication that an objective variable can be manipulated without affecting the perceived corresponding subjective variable, and vice versa.

Data from this project showed a general softening and reduction in toughness in ground beef patties as a result of MRNL addition. This is likely due to the fine particle size of the MRNL. The final step in manufacture of MRNL forces the lean through a screen with .05 inch diameter holes, thus maximum particle size of MRNL is .05 inch, as compared to .19 inch particle size for controls. Despite the objective texture measurements, consumer sensory panelists found no differences among MRNL levels for texture. It may be that although product toughness was decreased by MRNL, it was not decreased to undesirable levels as perceived by consumer panelists. Consumer panelists did find patties made with MRNL juicier than controls.

Because consumers expect low-fat ground beef to have acceptable tenderness, juiciness and flavor, it is possible that MRNL could be used in manufacture of low-fat processed meat products. Mechanically recovered lean levels of as little as 15% in low-fat patties (10%) are sufficient to mimic sensory texture and juiciness of 20% fat patties. Higher levels of MRNL were tested in this study in an attempt to determine maximum levels of incorporation, however due to potential color problems revealed in a previous study, MRNL levels of 15% or less are more practical for industry applications.

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