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Abstract
Irradiation did not influence bitter, bloody, burnt, chemical, fat-like, juiciness, liver-like, beef identity, metallic, rancid, sour, sweet, and toughness flavor/textural attributes, beef aroma, or off-odor in precooked ground beef patties. Irradiation slightly increased the animal hair flavor note, but intensity levels were <1 on the 15-point sensory scale. Except for>10% fat non-irradiated controls, reheated precooked patties had a slight sour, ammonia-like, top note. Irradiation at 3.5 kilograys (kGy) increased external redness in vacuum-packaged patties, but not in aerobic packages. Aerobic packaging with or without irradiation decreased external precooked redness. Oxidative rancidity increased when patties were irradiated in aerobic but not in vacuum packages. Reduction of oxygen in vacuum bags extended the shelf life of the precooked ground beef patties, at least in terms of oxidative rancidity. Precooking ground beef patties, irrespective of irradiation or packaging type, posed sensory disadvantages, and improvements to the precooking process are needed before irradiating at low-dose levels is appropriate.

Keywords
Cattlemen's Day, 1996; Kansas Agricultural Experiment Station contribution; no. 96-334-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 756; Beef; Irradiation; Ground beef; Precooked; Sensory; Color

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SENSORY TRAITS, COLOR, AND SHELF LIFE OF LOW-DOSE IRRADIATED, PRECOOKED, GROUND BEEF PATTIES

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Summary

Irradiation did not influence bitter, bloody, burnt, chemical, fat-like, juiciness, liver-like, beef identity, metallic, rancid, sour, sweet, and toughness flavor/textur al attributes, beef aroma, or off-odor in precooked ground beef patties. Irradiation slightly increased the animal hair flavor note, but intensity levels were <1 on the 15-point sensory scale. Except for 10% fat non-irradiated controls, reheated precooked patties had a slight sour, ammonia-like, top note. Irradiation at 3.5 kilograys (kGy) increased external redness in vacuum-packaged patties, but not in aerobic packages. Aerobic packaging with or without irradiation decreased external precooked redness. Oxidative rancidity increased when patties were irradiated in aerobic but not in vacuum pa ckages. Reduction of oxygen in vacuum bags extended the shelf life of the precooked ground beef patties, at least in terms of oxidative ran cidity. Precooking ground beef patties, irrespective of irradiation or packaging type, posed senso ry disadvantages, and improvements to the precooking process are needed bef ore irradiating at low-dose levels is appropriate.

(Key Words: Irradiation, Ground Beef, Precooked, Sensory, Color.)

Introduction

Consumer concerns regarding foodborne pathogens, especially *Escherichia coli* O157:H7, are well documented. Low level X-ray irradiation is effective in reducing these pathogens. However, consumers have historically been skeptical of irradiation. Precooked, packaged, ground beef patties are an important item in the food service industry. Our objective was to determine flavor, aroma, color, and product life of precooked ground beef patties of two raw fat levels (10 and 22%) and with two packaging systems (aerobic and vacuum), exposed to t wo dose levels (2 and 3.5 kGy) of nonradioactive irradiation or not irradiated.

Experimental Procedures

Closely trimmed beef knuckles and beef fat trim were coarsely ground separately through a 3/8 in. plate, mixed to obtain fat levels of 10 and 22%, then ground twice through a 1/8 in. plate. Twelve 1/4 lb patties per treatment, made with a Hollymatic patty maker, were stacked individually on metal broiler pans and precooked to 160°F internally in a forced air oven set at 350°F, then crust frozen (40 °F). After precooking, patties were either vacuum packaged in oxygen-barrier bags or sealed in oxygen-permeable bags, frozen (4 °F), and freezer stored for about 60 hr. Then they were removed, boxed, and shipped under dry ice to arrive within 6 hr at Iowa State University's irradiation facility. After stabilizing the product temperature (17 °F) overnight, patties were treated with either 2.0 or 3.5 kGy of nonradioactive X-rays. One set of patties was not irradiated. After irradiation, the product was shipped back to KSU and stored at 2 °F overnight.

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Eight frozen precooked patties per treatment per replication were reheated with a combination broil (1.5 min)/bake (4.1 to 4.3 min per side) to 165 °F internally. Fifteen flavor/texture attributes (animal hair, bitter, bloody, browned/roasted, burnt, chemical, fat-like, juiciness, liver-like, beef identity, metallic, rancid, sour, sweet, and toughness) were assessed by five professional flavor-profile panelists using a 15-point scale (0 = none to 15 = very intense; 0.5 intervals). Each panelist received one patty per treatment. Beefy aroma and off-odors were evaluated at 2 and 6 min during reheating and after removal from the reheating oven. Cooking loss percentage, Warner-Bratzler shear force, and cooked internal color traits also were evaluated on reheated patties.

Two patties were displayed at 2 °F under 150 foot candles intensity from Deluxe Warm White fluorescent lighting and evaluated instrumentally for color reflectance at days 0, 7, 14, and 21. Two additional thawed precooked patties per treatment per replication were tested (no display) for purge (drip loss), pH, and total microbial plate count (TPC) using standard procedures. Rancidity was measured with a modified 2-thiobarbituric acid (TBA) analysis, before and after display.

Data were analyzed as a strip-split plot design using the maximum likelihood mixed model analysis of the Statistical Analysis System. Least square means were determined, and the statistical significance level was set at $P \leq .05$.

Results and Discussion

Irradiation dose level, package type (Table 1), and fat percentage (data not shown) did not affect bloody, burnt, chemical, beef identity, metallic, rancid, sour, and sweet flavor or beef aroma attributes in reheated patties. Intensity levels for animal hair, burnt, chemical, rancid, and sweet were <1 on the sensory scale for all treatments. Irradiation at 2.0 kGy increased the browned/roasted notes for AP patties.

Irradiation dose level, package type (Table 1), and fat percentage (data not shown) did not affect the intensities of cooking and cooked off-odors. However, nonirradiated patties had a sweet-dough-like aroma during reheating, whereas irradiated samples were described as having heated oil aromatics. After reheating, all treatments, except 10% fat nonirradiated controls, had a slight sour, ammonia-like, top note aroma with an underlying slight impression of animal habitat odor. Precooking ground beef patties, with or without irradiation treatment, caused sensory problems, which were not affected positively or negatively by irradiation.

Vacuum-packaged (VP) precooked patties were redder on the surface at all display days and dose levels than AP patties. Redness decreased from 7 to 14 days in AP patties and from 0 through 14 days in VP samples, but increased from 2.0 to 3.5 kGy in VP samples. Packaging, in combination with irradiation treatment, had more effect on precooked external color than did fat level, especially for 3.5 kGy AP patties, which were redder than either 0 or 2.0 kGy samples. The retail marketing of irradiated, vacuum-packaged, precooked, ground beef may be hindered by the formation of the persistent red pigment, and the marketing of aerobic-packaged patties may be hampered by the trend toward yellowness.

Irradiation dose level, package type, and fat level did not affect instrumental internal cooked-color values.

Shear force was not affected by irradiation dose level, package type (Table 1), or fat level (data not shown). Neither fat nor irradiation dose level influenced cooking loss or purge percentages. Cooking loss was greater for AP than VP patties (Table 1), but the reverse was true for purge values. Doses of 2.0 or 3.5 kGy decreased total microbial plate counts, as expected. However, plate counts were low even in nonirradiated precooked patties.

Higher TBA values were observed for AP than for VP patties at all display days, fat levels, and irradiation dose levels (data not shown). No difference was observed between display days, fat levels, or dose level for VP patties, but longer display, higher fat levels, or irradiation dose increased TBA of AP patties.

Table 1. Flavor/Aroma Sensory Attributes[a], Warner-Bratzler Shear Force (WBS), Cooking Loss, Precooked Total Microbial Plate Counts (TPC), and Purge Prior to Display as Affected by Irradiation Dose Level and Package Type[b]

	Dose, kGy				Package Type		
Attribute	0	2.0	3.5	SE	Aerobic	Vacuum	SE
Sensory (reheated)							
Bloody	1.3	1.1	1.2	.2	1.1	1.3	.2
Burnt	.2	.4	.3	.2	.3	.3	.2
Chemical	.2	.3	.3	.1	.3	.3	.1
Beef identity	10.8	10.9	10.7	.2	10.8	10.8	.1
Metallic	1.5	1.5	1.3	.2	1.4	1.4	.2
Rancid	.0	.0	.1	.0	.1	.0	.0
Sour	1.5	1.5	1.5	.3	1.5	1.5	.3
Sweet	.6	.6	.6	.2	.6	.6	.2
Beef aroma	9.4	8.7	7.8	.6	8.5	8.8	.6
Off odor - 2 min	7.7	8.1	7.8	.6	8.0	7.8	.5
- 6 min	7.9	8.0	7.9	.4	8.0	7.8	.4
- Final	2.0	4.1	5.2	1.5	4.4	3.1	1.4
WBS, kg[c]	2.8	2.9	2.7	.1	2.8	2.8	.1
Cooking loss, %	17.3	17.3	17.9	.8	18.7[e]	16.3[f]	.7
TPC[d]	1.9[e]	1.2[f]	<1.0[f]	.2	1.3	1.4	.1
Purge, %	.1	.1	.1	.1	.0[f]	.1[e]	.1

[a]15 point scale: 0 = none to 15 = very intense.
[b]Data for 10 and 22% fat are combined.
[c]Two 1.2 in.-wide strips per patty.
[d]Expressed as $\log_{10}$ CFU/g.
[ef]Mean values within the same row within a variable with different superscripts are different (P<.05).