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

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Summary

Irradiation of raw ground beef patties had minimal effects on flavor and aroma of patties after cooking. Oxidative rancidity increased when patties were irradiated in aerobic but not in vacuum packages. Irradiation of vacuum-packaged ground beef patties produced a more stable color. In both packaging types, irradiation significantly reduced microbial growth during storage.

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

Introduction

Outbreaks of foodborne infecti ons involving meat products have increased consumer awareness of food pathogens, especially *Escherichia coli* O157:H7. In addition to good manufacturing practices, irradia tion is a possible way to help assure meat safety. A dose of 2.5 kilograys (kGy) reduces f ive major pathogens in ground beef by 4 to 10 $\log_{10}$ (a 4 $\log_{10}$ reduction kills 99.99%). The World Health Organization states that no toxicolog ical hazard resulted from consuming food irradiated with up to 10 kGy. Historically, consumers have rejected irradiation, but recent studies indicate that consumer acceptance is increasing. Our objective was to determine how irradiation, package type, and fat level influence flavor, aroma, and shelf life of raw ground beef patties. Raw ground beef patties of two fat levels (10 and 22%) and with two packaging systems (aerobic and vacuum) were exposed to two dose levels (2.0 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 using a hand press, were stacked individually, crust frozen at 40 °F for 20 min, then were either vacuum packaged in oxygen barrier bags (VP) or sealed in oxygen-permeable bags (AP) and frozen at 4 °F. Patties were freezer stored for about 60 hr, then 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 kilograys (kGy) of non-radioactive X-rays. One set of patties was not irradiated. After irradiation, the product was shipped back to KSU and stored at 2 °F overnight.

Eight frozen patties per treatment per replication were broiled 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-odor were evaluated on broiled patties, as well as cooking loss percentage, Warner-Bratzler shear force, and cooked internal color traits.

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Two raw patties were displayed at 2 °F under 150 foot candles intensity from fluorescent Deluxe Warm White lighting and evaluated instrumentally for color reflectance at days 0, 7, 14, and 21. Two additional thawed raw patties per treatment per replication were tested before 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 $P<.05$.

Results and Discussion

Irradiation dose level, package type (Table 1), and fat percentage (data not shown) did not affect burnt, chemical, juiciness, liver-like, sour, sweet, and toughness flavor/textural attributes of cooked beef patties or beefy aroma. Stronger metallic notes were observed for vacuum-packaged (VP) patties than for their aerobically packaged (AP) counterparts, which may have been a result of the packaging materials. Intensity levels for animal hair, burnt, chemical, rancid, and sweet were <1 in the sensory scale for all treatments, except that animal hair was greater for 10% fat, 3.5 kGy VP (mean=1.5) than for control or 2.0 kGy samples (data not shown). No off-odors were detected.

Determining optimum packaging conditions and controlling packaging permeability can control sensory changes in raw ground beef patties. Low-dose irradiation treatment, even up to 3.5 kGy, had limited or no effect on flavor, texture, or aroma attributes of raw ground beef patties. Package type had a greater impact on flavor than either irradiation or fat level.

Vacuum-packaged patties were darker than aerobically packaged counterparts at all display days. Nonirradiated patties were lighter colored than irradiated patties at day 0, but not different at 7, 14, and 21 days. All VP patties were redder than AP at days 7, 14, and 21 of display, except for day 7 nonirradiated controls. At day 0, nonirradiated VP patties were redder than AP patties, but no difference occurred between packaging types at 0 day for irradiated samples. Darker and less red AP patties may have been caused by moisture condensation and formation of ice crystals, which may have destabilized or masked the color. Reduced redness of irradiated beef may be detrimental to its consumer acceptance. Color degraded faster with aerobic than with vacuum packaging. The general trend toward yellowing in both nonirradiated and irradiated patties may limit the use of that packaging, especially at the retail level.

Fat and irradiation dose levels did not affect instrumental cooked internal-color values (data not shown), but VP samples were redder.

Shear force and pH were not affected by irradiation dose level, package type (Table 1), or fat level. Neither fat nor irradiation dose level influenced cooking loss percentage. Cooking loss was less in VP than AP patties. Total microbial plate count reductions of 1.6 $\log_{10}$ and 2.0 $\log_{10}$ (1 log=90% reduction, 2 logs=99% reduction) from non-irradiated was observed for 2.0 and 3.5 kGy irradiated patties, respectively. Fat level and packaging type did not affect TPC. Percent purge was higher for VP patties than AP patties within a fat level.

Higher TBA values (more oxidative rancidity) were observed at both display days for AP than VP patties (data not shown). TBA values were higher for 2.0 and 3.5 kGy AP patties at day 21 than for nonirradiated controls. In addition, TBA values increased in AP irradiated samples from 0 to 21 days. No increase in rancidity occurred in VP samples. Reduction of oxygen through vacuum-packaging minimized autoxidation and thus helped extend the shelf life of raw ground beef patties.

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

	Dose, kGy				Package Type		
Attribute	0	2.0	3.5	SE	Aerobic	Vacuum	SE
Sensory (cooked)							
Browned/roasted	8.1	8.1	8.1	.3	8.1	8.1	.3
Burnt	.2	.4	.4	.2	.3	.3	.1
Chemical	.1	.4	.5	.2	.3	.3	.1
Juiciness	6.2	5.7	6.2	.4	6.0	6.1	.3
Liver-like	1.8	1.3	1.1	.3	1.5	1.3	.2
Metallic	2.9	2.9	2.9	.5	2.6[e]	3.2[d]	.5
Sour	1.5	1.5	1.5	.2	1.5	1.5	.2
Sweet	.7	.6	.7	.2	.7	.7	.2
Toughness	6.2	6.2	6.2	.3	6.1	6.3	.3
Beef aroma	10.0	10.3	10.0	.4	10.1	10.1	.3
WBS, kg[b]	3.0	2.9	2.9	.1	3.0	2.9	.1
Cooking loss, %	34.7	36.7	35.0	1.0	36.1[d]	34.9[e]	.8
TPC[c]	4.4[d]	2.8[e]	2.4[f]	.4	3.1	3.3	.4
pH	5.8	5.8	5.8	.1	5.8	5.8	.1

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