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Abstract
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Keywords
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FLAVOR AND AROMA OF LOW-DOSE IRRADIATED, BONELESS, PORK CHOPS

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Summary

Irradiation and irradiation source had little to no effect on flavor and aroma of boneless pork chops, either frozen or chilled. Coupled with consumer concerns about food safety and well-documented improvement in consumer attitudes about irradiated foods, irradiation of boneless pork chops has promising potential for market acceptance.

(Key Words: Irradiation, Flavor, Aroma.)

Introduction

Recent events involving food-borne infections in meat products have increased consumer awareness of possible food contamination with pathogens, especially *Escherichia coli* O157:H7. Of surveyed consumers, 43% were very concerned with food safety. Irradiation is one possible method to increase meat safety, especially when combined with good manufacturing practices. The World Health Organization stated that no toxicological hazard resulted from consuming food irradiated with up to 10 kilograys (kGy). Historically, consumers have rejected irradiation, but several studies indicate that consumer attitudes toward irradiation are changing. Even though the effects of irradiation on the survival of microorganisms in food have been well studied, little is known about the effects of low-dose irradiation on meat quality. Meat quality ultimately will determine consumer acceptance. The objective of this study was to determine the effects of irradiation on flavor and aroma of chilled and frozen boneless pork chops in two packaging systems.

Procedures

Nine center-cut boneless chops from each of 42 loins (NAMP #412B) per replication were cut 1.25 in thick. Loins were randomly assigned to temperature treatment and package type before cutting. Six chops per loin were assigned randomly to each of the six remaining treatments (irradiation). The remaining three chops per loin were assigned randomly to treatments to fulfill chop requirements. Individual loins and chops were tracked throughout the study. Only chops with NPPC color, firmness/wetness, and marbling scores of 2, 3, or 4; loin eyes of 4.5 to 6.5 in^2; and Minolta L* (lightness) values of 40 to 58 were used. Chops were either vacuum-packaged (VP) or packaged aerobically (AP). After packaging, chops were boxed and stored either frozen at 0 $\pm$ 3°F or chilled at 37 $\pm$ 3°F. Boxed products were stored for about 60 h and shipped with arrival within 24 h at either Iowa State University's Linear Accelerator Facility (electron beam, ISU, Ames, IA) or FOOD TECHnology Service, Inc. (Co^{60}, Mulberry, FL). After product temperature was stabilized overnight to either 0 or 37°F, chops were treated with either 0, 1.5, or 2.5 kGy (chilled) or 0, 2.5, or 3.85 kGy (frozen) of either nonradioactive electron beam (EB) or radioactive Co^{60}. After irradiation, products were stored overnight, returned to Kansas State University, and stored at either 0 $\pm$ 3 or 37 $\pm$ 3°F for about 60 h. Prior to broil-

[1]Cryovac North America, Mount Prospect, IL.
[2]National Live Stock and Meat Board, Chicago, IL.

ing, frozen chops were thawed at 34 ± 2°F overnight.

Five chops for each treatment for each replicate were broiled to 165°F internally, as measured by thermocouples attached to a temperature recorder. Eighteen texture/flavor attributes: animal hair-fat, animal hair-lean, bitter, bloody, browned/roasted, burnt, chemical-fat, chemical-lean, fat-like, juiciness, liver-like, pork identity, metallic, rancid-fat, rancid-lean, sour, sweet, and toughness were assessed by five professional flavor profile panelists using a structured 15-point scale (0 = none to 15 = very intense; 0.5 intervals). To avoid animal differences, each panelist evaluated treatment samples from the same loin. Each panelist received one chop per treatment. Pork identity aromas and off-odors were evaluated on raw and cooked chops by two professional aroma profile panelists using the 15-point scale. Off-odors also were evaluated during broiling.

Results and Discussion

Chilled Boneless Pork Chops. Dose level, irradiation source, and package type did not affect fat-like, juiciness, liver-like, metallic, and toughness flavor/textural attributes (Table 1). Animal hair-fat, animal hair-lean, burnt, chemical-fat, chemical-lean, liver-like, rancid-fat, and rancid-lean flavor intensities were inconsistent, but all treatment intensity levels were < 1.6 on the sensory scale. Intensity levels of < 1.6 would not be detected by most consumers of boneless pork chops.

Raw and cooked pork-aroma attributes were not influenced by dose level, package type, or irradiation source (Table 1). No off-odors were detected in the raw or cooked state or during broiling.

Bloody flavor increased as irradiation dose increased from 1.5 to 2.5 kGy. Electron beam (EB) VP chops had stronger sour notes than Co^{60} VP samples. Bitterness notes increased in AP samples as irradiation dose increased from 1.5 to 2.5 kGy and was greater in 2.5 kGy AP than in 2.5 kGy VP chops. Pork identity was less for EB VP 2.5 kGy than EB VP 1.5 kGy, EB AP 2.5 kGy and Co^{60} VP 2.5 kGy samples. Browned/roasted notes decreased in EB AP from control to 2.5 kGy samples, but Co^{60} AP and VP samples were not affected by dose. Co^{60} VP and EB AP controls had more browned/roasted notes than EB VP controls. Sweet notes were lower in Co^{60} AP 2.5 kGy than EB AP 2.5 kGy samples.

Frozen Boneless Pork Chops. Dose level, irradiation source, and package type did not affect bitterness, fat-like, pork identity, sour, and sweet flavor attributes (Table 2). Animal hair-fat, animal hair-lean, burnt, chemical-fat, chemical-lean, liver-like, and rancid-fat flavor intensities were inconsistent, but all treatment intensity levels were < 1 on the sensory scale. Intensity levels of < 1 would not be detected by most consumers of boneless pork chops. No rancid-lean flavor was detected.

Raw and cooked pork-aroma attributes were not influenced by dose level, package type, or irradiation source (Table 2). No off-odors were detected during broiling or in cooked chops, and raw off-odor was inconsistent.

Bloody flavor was greater in VP chops then in AP. Metallic notes were lower in controls than irradiated samples. Toughness increased from AP control to 3.85 kGy AP samples, but VP samples were not influenced by dose. Browned/roasted notes were lower in EB 3.85 kGy than either EB 2.5 kGy or Co^{60} 3.85 kGy samples, and EB VP was lower for browned/roasted than EB AP chops. Juiciness was lower for Co^{60} VP 2.5 kGy samples than for Co^{60} AP 2.5 kGy.

Although a number of flavor/texture notes were affected by low-dose irradiation, no undesirable flavor scores exceeded 1.9 on a 15-point scale as scored by the professional panelists. This level of response should not result in consumer detection or rejection.

Table 1. Flavor/Textural and Aroma* Attributes for Irradiated Chilled Boneless Pork Chops as Affected by Dose Level, Irradiation Source, and Package Type

	Dose, kGy				Irradiation source[c]			Package type[d]		
Attribute	0	1.5	2.5	SE	EB	Co^{60}	SE	AP	VP	SE
Flavor/Textural										
Bloody	1.6[b]	1.4[b]	1.9[a]	.3	1.7	1.5	.3	1.5	1.7	.3
Burnt**	.2	.1	.1	.1	.1	.1	.1	.1	.1	.1
Chemical-fat**	.5	.9	1.0	.2	.8	.8	.2	1.1	.5	.2
Fat-like	1.3	1.5	1.3	.3	1.3	1.4	.3	1.3	1.3	.3
Juiciness	7.3	6.9	7.1	.4	7.1	7.1	.4	7.0	7.2	.4
Liver-like**	.1	.2	.3	.1	.2	.2	.1	.2	.2	.1
Metallic	1.7	1.6	1.9	.4	1.7	1.8	.4	1.7	1.8	.4
Rancid-fat**	.2	.5	.5	.1	.4	.4	.1	.6	.2	.1
Rancid-lean**	.0	.1	.2	.1	.1	.1	.1	.2	.0	.1
Toughness	6.6	6.8	6.8	.4	6.7	6.8	.4	6.9	6.7	.4
Aroma										
Raw pork identity	1.4	2.2	2.0	.3	1.7	2.0	.3	1.6	2.1	.3
Cooked pork identity	12.2	11.8	11.5	.2	12.0	11.6	.1	11.8	11.9	.1
Raw off-odor	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cooking off-odor	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cooked off-odor	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

[ab]Mean values within the same row within a variable with different superscripts are different ($P<0.05$).
[c]EB = electron beam; Co^{60} = $Cobalt^{60}$.
[d]AP = aerobic packaged; VP = vacuum packaged.
*15 point scale: 0 = none to 15 = very intense.
**No superscripts for statistical differences are shown, because these attributes did not satisfy the assumption of continuous response, i.e., they were affected inconsistently.

Table 2. Flavor/Aroma* Attributes for Irradiated Frozen Boneless Pork Chops as Affected by Dose Level, Irradiation Source, and Package Type

	Dose, kGy				Irradiation source[c]			Package type[d]		
Attribute	0	2.5	3.85	SE	EB	Co^{60}	SE	AP	VP	SE
Flavor										
Animal hair-fat**	.2	.4	.4	.2	.3	.3	.1	.3	.3	.1
Animal hair-lean**	.1	.4	.5	.2	.5	.3	.2	.4	.3	.2
Bitterness	1.0	1.0	1.0	.2	1.0	1.0	.2	1.0	1.0	.2
Bloody	1.6	1.8	1.7	.3	1.7	1.7	.3	1.6[b]	1.8[a]	.3
Burnt**	.1	.0	.0	.03	.0	.1	.03	.1	.0	.03
Fat-like	1.2	1.2	1.1	.3	1.2	1.1	.3	1.2	1.2	.3
Metallic	1.6[b]	1.9[a]	1.9[a]	.4	1.8	1.8	.4	1.7	1.8	.4
Pork identity	11.9	11.7	11.8	.2	11.8	11.9	.2	11.8	11.8	.2
Rancid-lean	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Sour	1.7	1.8	1.8	.3	1.7	1.8	.3	1.8	1.8	.3
Sweet	1.2	1.2	1.2	.1	1.2	1.2	.1	1.2	1.2	.1
Aroma										
Raw pork identity	1.2	1.8	1.1	.3	1.6	1.1	.2	1.3	1.4	.2
Cooked pork identity	12.0	11.9	11.5	.1	11.9	11.7	.1	11.7	11.9	.1
Raw off-odor	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cooking off-odor	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
Cooked off-odor	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

[ab]Mean values within the same row within a variable with different superscripts are different ($P<0.05$).
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