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QUALITY CHARACTERISTICS AND SENSORY EVALUATION OF MEATS IRRADIATED UNDER VARIOUS PACKAGING CONDITIONS

ELSA A. MURANO[1,2], PETER S. MURANO[1,3], and DENNIS G. OLSON[2,3]
Departments of [1]Microbiology, Immunology and Preventive Medicine, [2]Animal Science, and [3]Food Science and Human Nutrition
Iowa State University, Ames, Iowa, 50011, USA

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BACKGROUND

Food irradiation is a technology that has been studied for over 40 years, and whose benefits in increasing the microbial safety and shelf-life of meats is unquestioned. Determining whether this process causes undesirable changes to food is important, since consumer acceptance of this technology will not occur if processing by irradiation adversely affects food quality. It has been speculated that irradiation may affect the quality of fresh meats (Champagne and Nawar, 1969). Packaging under vacuum, or at low temperatures, have been suggested as ways to reduce the number of oxygen radicals that are formed as a result of irradiation. Given the increased interest in this technology, it would be significant to evaluate the effect that such processing parameters may have on the quality of fresh meats.

OBJECTIVES

(1) to determine whether medium-dose irradiation would result in a detectable difference between irradiated and unirradiated samples, and (2) to determine the effect of packaging atmosphere, irradiation temperature, and time after irradiation on specific sensory attributes of irradiated ground beef.

MATERIALS AND METHODS

Sample Preparation. Ground turkey patties, ground beef patties and pork chop meat were used. For sensory evaluation of samples by the triangle test of difference, meat samples were divided into two groups: one group was packaged in air with polyolefin stretch/shrink, oxygen-permeable overwrap film. The second group was packaged under vacuum in a high-barrier polyethylene pouch. For sensory evaluation by descriptive analysis, only ground beef patties were used. Patties were divided into three groups: Group 1 being packaged under air (A), Group 2 being packaged under vacuum (V) and Group 3 being packaged under air followed by inserting the packaged sample inside a polyethylene pouch and packaging it under vacuum (V/A). The latter samples were irradiated under vacuum but stored in air by removing the outer pouch.

Irradiation of Samples. Samples were irradiated at the ISU Linear Accelerator Facility. A target dose of 2 kGy or 5 kGy was delivered by electron beam at 10 MeV and 8.1 kW. Actual absorbed dose was determined by electron paramagnetic resonance of alanine dosimeters. The average minimum and maximum doses for samples irradiated at 2 kGy were 1.9 and 2.4 kGy, respectively. For samples irradiated at 5 kGy, the average minimum and maximum doses were 4.8 and 5.1 kGy, respectively. Ground turkey patties, pork chops and ground beef patties used in the triangle test were irradiated at -3°C, and immediately placed in storage at -25°C for 3 days, at which time they were broiled and served to panelists. For evaluation by descriptive analysis, only ground beef patties were used, with patties irradiated at -3°C stored at -25°C, and patties irradiated at 6°C stored at at 6°C.

Sensory Evaluation. Ground turkey patties, ground beef patties and pork chops, packaged under air or vacuum, were evaluated three days after irradiation at either 2 kGy or 5 kGy. Unirradiated samples served as controls. Samples were grilled until fully cooked, and served in a triangle test. Ground beef patties labeled "A", "V" or "V/A"were used in descriptive analysis. Either 1 day or 7 days after irradiation, the patties were broiled and served to panelists. Panelists were asked to mark on a 15-cm horizontal line their impressions of each sample, according to: flavor (weak vs. strong), texture (tough vs. tender), and juiciness (dry vs. moist) (Stone and Sidel, 1985).

RESULTS

Panelists were unable to detect a difference between irradiated and nonirradiated ground turkey by the triangle test, regardless of whether the samples were irradiated while packaged under air or vacuum (Table 1). In addition, no difference was seen even when the turkey patties were irradiated at the relatively high dose of 5 kGy. A significant difference was detected between irradiated and nonirradiated ground beef and pork chops, but only when these were irradiated under air. Based on these results, further evaluation of irradiated samples was conducted by descriptive analysis, in order to pinpoint the nature of the differences detected. A comparison between ground beef patties irradiated under air and stored under air, irradiated under vacuum and stored under vacuum, or irradiated under vacuum and stored under air were carried out. In addition, the effect of temperature of irradiation and storage, as well as the time after irradiation when the samples were actually served to panelists, were evaluated. There was no significant difference between any of the irradiated samples and the controls when irradiated at 6°C, whether stored for 1 or 7 days (Table 2). When samples were irradiated at -3°C and sampled 1 day later, a significant difference was observed in texture between samples irradiated under vacuum but stored under air, and the rest of the samples (Table 3). The difference consisted of patties being deemed more tender than any of the other samples. A significant difference in juiciness was also detected in patties irradiated at -3°C and sampled 1 day later, with patties irradiated and stored under vacuum being deemed more juicy than any of the other samples. When patties were irradiated at -3°C and sampled 7 days later, no significant difference was observed between the irradiated and control samples in terms of any of the descriptive parameters, regardless of irradiation or storage atmosphere.

DISCUSSION AND CONCLUSIONS

Lynch et al. (1991) reported that irradiation of turkey breast fillets in air resulted in 54% of panelists deeming the flavor of the samples as acceptable, compared with 66% of the panelists accepting the flavor of unirradiated controls. Irradiation under vacuum resulted in 41% of the panelists finding the irradiated samples acceptable, compared with 45% of the unirradiated controls. It is difficult to conclude

from that study whether the differences were significant, since only 10 panelists were used. Given that we detected no difference in turkey patties irradiated under air, analysis of all meat samples for compositional differences was conducted. The fat content of the three meat samples was 1.1% for turkey, 7.5% for pork chops, and 14.5% for ground beef. It is possible that the inability of the panelists to detect a difference between irradiated and nonirradiated turkey patties was due to its relatively low fat content, compared with the other meat products. Since irradiation of meats accelerates auto-oxidation of lipid in the presence of oxygen (Lea et al., 1960), differences detected with irradiation of ground beef patties and pork chops packaged in air may have been due to enhanced lipid oxidation of these products.

Evaluation of irradiated ground beef patties by descriptive analysis revealed no difference between irradiated and unirradiated samples, but only in samples irradiated at 6°C. Differences in texture and juicines of patties irradiated at -3°C were observed. A study by Hanis et al. (1989) with chicken irradiated either chilled (10°C) or frozen (-15°C) showed that the quality of the flavor decreased with increasing temperature. In our study, however, the differences that were observed in frozen product as compared with refrigerated product were in ground beef samples irradiated under vacuum. Further, these differences were positive, since they represented desirable changes in texture and juiciness. The differences observed in texture and juiciness of patties irradiated at -3°C under vacuum were not detected by panelists when the samples were served 7 days after irradiation. It is possible that long-term storage at -25°C resulted in changes in quality that masked any due to irradiation, thus causing the irradiated samples to become as tough and dry as the unirradiated controls. Mattison et al. (1986) showed that differences in sensory evaluation by triangle test were detected between irradiated and unirradiated pork loins 2 days after irradiation, but no difference was detected when the meat was sampled 7 days after irradiation.

It is evident that irradiation did not negatively affect the quality of fresh meats. There are certain irradiation parameters that can be manipulated to produce value-added fresh meats with this process. Vacuum packaging may offer some advantages to irradiating the product under air, in terms of minimizing lipid oxidation immediately after irradiation. Also, it appears to enhance the texture and juiciness of ground beef.

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Table 1:Sensory Evaluation of Turkey, Pork and Beef Samples

Samples Tested	Turkey	Pork	Ground Beef
C vs. 2kGy Air	17/39	20/39	20/39
C vs. 5kGy Air	17/39	22/39	19/39
C Air vs. C Vac	17/39	14/39	18/39
C vs. 2kGy Vac	15/39	17/39	16/39
C vs. 5kGy Vac	12/39	15/39	15/39

Significant difference at 0.05 level with 19/39 correct, and at 0.01 level with 21/39 correct.

Table 2: Descriptive Analysis of Ground Beef Patties

Irradiated at 6°C and Tested 1 day Later

	Flavor	Texture	Juiciness
Control	7.6	10.6	7.5
Irrad Air	7.0	10.7	7.6
Irrad Vac	8.3	11.5	8.0
Irrad Vac, stored Air	7.3	10.5	8.6

Irradiated at 6°C and Tested 7 day Later

	Flavor	Texture	Juiciness
Control	8.9	9.4	7.3
Irrad Air	8.4	10.1	7.2
Irrad Vac	9.5	9.5	8.3
Irrad Vac, stored Air	8.8	9.1	8.6

*Significantly different by ANOVA, 15 panelists X 3 rep.

Table 3:Descriptive Analysis of Ground Beef Patties

Irradiated at -3°C and Tested 1 day Later

	Flavor	Texture	Juiciness
Control	9.2	7.5	5.3
Irrad Air	7.7	8.0	6.1
Irrad Vac	7.5	9.7	9.2*
Irrad Vac, stored Air	8.4	10.8*	7.4

Irradiated at -3°C and Tested 7 day Later

	Flavor	Texture	Juiciness
Control	8.1	9.3	6.1
Irrad Air	7.9	8.6	6.0
Irrad Vac	7.9	9.8	7.1
Irrad Vac, stored Air	7.8	9.1	5.5

*Significantly different by ANOVA, 15 panelists X 3 rep.