

Effects of Electron Beam Irradiation and Antimicrobials on the Volatiles, Color and Texture of Ready-to-Eat Turkey Breast Roll

A.S. Leaflet R1987

M.J. Zhu, graduate assistant,
A. Mendonca, Professor of Food Science and Human
Nutrition

E.J. Lee, postdoctoral research associate

K.C. Nam, postdoctoral research associate

M. Du, Professor, University of Wyoming

H.A. Ismail, graduate assistant

D.U. Ahn, Professor of Animal Science Department

Summary and Implications

Adding 2% SL increased the hardness, springiness, cohesiveness, chewiness, and resilience of breast rolls. The color a^* and b^* values of turkey rolls with 2% SL added were significantly lower than those of the control, and this difference was maintained after irradiation and during storage. Breast rolls containing antimicrobials had more lipid oxidation than control. Irradiation promoted the formation of dimethyl disulfide and dimethyl trisulfide. Adding PB in breast rolls greatly increased the formation of benzene during irradiation. It also implies that certain spices or foods containing high amounts of phenolic compounds may not be suitable for irradiation. The combination of SL and SDA has a strong potential as an antimicrobial treatment for RTE meats, but low-dose irradiation (<2.0 kGy) is preferred due to side effects of irradiation.

Introduction

The initial contamination with pathogenic microorganism and their proliferation during handling and storage directly compromise the safety of foods, especially in ready-to-eat meat (RTE) products which are consumed directly without further heating. Of those common food-borne pathogens, *Listeria monocytogenes* apparently poses the biggest threat due to its being ubiquitous in the environment and its ability to multiply during refrigerated storage. Irradiation is an effective way to eliminate pathogens, including *L. monocytogenes*, but irradiation also causes quality changes in meat. Since the quality changes in irradiated meat are dose-dependent, only low-dosage irradiation is recommended in order to minimize those changes. The problem is that some pathogens can survive low-dose irradiation. Those injured cells might repair themselves and then proliferate during storage at 4 °C. In RTE turkey ham and breast rolls showed that a significant number of inoculated *L. monocytogenes* survived low-dose irradiation and proliferated during

refrigerated storage. These results suggest that additional hurdles are necessary in order to control bacteria growth during storage. Sodium lactate, sodium diacetate, and potassium benzoate are extensively used to extend the shelf-life and ensure the safety of food products. Despite the effectiveness of antimicrobial additives in inhibiting the growth of microorganisms, high concentration of antimicrobial additives, such as sodium diacetate, have a negative effect on the flavor of ham products. The objective of this study was to determine the effect of antimicrobials and irradiation on the quality of turkey breast rolls.

Materials and Methods

Oven-roasted turkey breast rolls with 6 different antimicrobial additives, which included basic formula without any preservatives (control), with 0.1% potassium benzoate (PB), 2% sodium lactate (SL), 0.1% potassium benzoate plus 2% sodium lactate (PB+SL), 2% sodium lactate plus 0.1% sodium diacetate (SL+SDA), and 0.1% potassium benzoate plus 2% sodium lactate plus 0.1% sodium diacetate (PB+SL+SDA) were prepared. Each antimicrobial treatment and the basic meat ingredients were mixed with ground turkey breast, stuffed, heat-processed in a smoke house to an internal temperature of 75 °C, immediately chilled with a cold water shower, and stored at 4 °C for 4 h. The cooked chilled rolls were sliced (2.0-cm-thick slices for texture measurement and 1.0-cm-thick slices for other quality analyses) and vacuum-packaged. The vacuum-packaged breast slices from each additive treatment were randomly divided into 3 groups and irradiated at 0, 1.0, or 2.0 kGy using a Linear Accelerator. After irradiation, RTE turkey breasts were stored at 4 °C up to 28 days. Color values, volatiles, and TBARS were analyzed at 0, 14, and 28 day. The texture characteristics were determined after 7 days of storage. Data were analyzed by the General Linear Model (GLM) of Statistical Analysis System (SAS 2000). The differences in the mean values were compared by the Tukey's multiple comparison, and mean values and standard deviation were reported ($P < 0.05$).

Results and Discussion

Adding 2% SL to breast rolls significantly increased the hardness, springiness, cohesiveness, chewiness, and resilience of breast rolls (Table 2). PB (0.1%) and SDA (0.1%) addition had no significant effect on texture. The increased values of texture parameters in 2% SL breast rolls probably due to the increased ionic strength, which increased the extraction of muscle proteins that helped

aggregation of proteins when heated. The exact reason for this increase is not clear, but could be related to the cross-linking of amino acid residues by irradiation. In amino acid solutions, irradiation-induced cross-linking of amino acids and the solution turned turbid after irradiation.

Adding SL decreased the color a^* and b^* values of both irradiated and nonirradiated breast rolls and remained low during storage. The change in color by SL could be related to the gelation of proteins. With 2% SL addition, the solubility of muscle proteins improved, which resulted in better gelation and changed the reflection of light on meat surface. Irradiation significantly increased the color a^* -values, but decreased the color b^* -values of turkey rolls. During storage, the color a^* -values of irradiated breast rolls remained higher than those of nonirradiated samples, while the color b^* -value remained lower. There was no difference in the color L^* - values among treatments. The increase in the color a^* -value after irradiation was suggested to be associated with the CO formed during irradiation.

The TBARS values of nonirradiated breast rolls with antimicrobial additives added were slightly higher than those of the control at 0 day of storage. Irradiation and storage increased TBARS values, which could be due to the presence of residual oxygen or oxygen-permeating packaging material during storage. Electron beam irradiation is reported to accelerate lipid oxidation of meat under aerobic conditions and the presence of salts might facilitate lipid oxidation in meat; however, the overall TBARS values were very low, since the breast rolls were made of high-quality raw turkey breast and were vacuum-packaged shortly after cooking, and the development of lipid oxidation was minor.

More than 40 different volatiles were detected. Antimicrobial treatments had little effect on most of the volatiles from turkey breast rolls. Addition of PB, however, greatly increased the content of benzene in the volatiles of irradiated breast rolls (Figure 1). Benzene has deleterious effects on human health and is a potential carcinogen. Thus, PB may not be an ideal antimicrobial additive for irradiated meat products. Our previous study showed that benzene and toluene also could be formed from amino acids upon irradiation, possibly generated from aromatic amino acids.

Irradiation increased the amount of sulfur compounds. The content of dimethyl disulfide and dimethyl trisulfide increased greatly in irradiated samples (Figure 1). The contents of both sulfides were lower in samples containing SDA (SL+SDA and PB+SL+SDA) at 0 day of storage. After 28 days of storage, however, the sulfides in PB+SL became lower than those of other treatments, which suggests that PB+SL might promote the degradation of dimethyl disulfide and dimethyl trisulfide. During the first 14 days of storage, the content of dimethyl trisulfide decreased significantly, while the content of dimethyl disulfide increased, which might be

partially due to the degradation of dimethyl trisulfide to dimethyl disulfide. As reported previously, irradiation increased the amount of acetaldehyde and other aldehyde volatiles, alkanes, and alkenes.

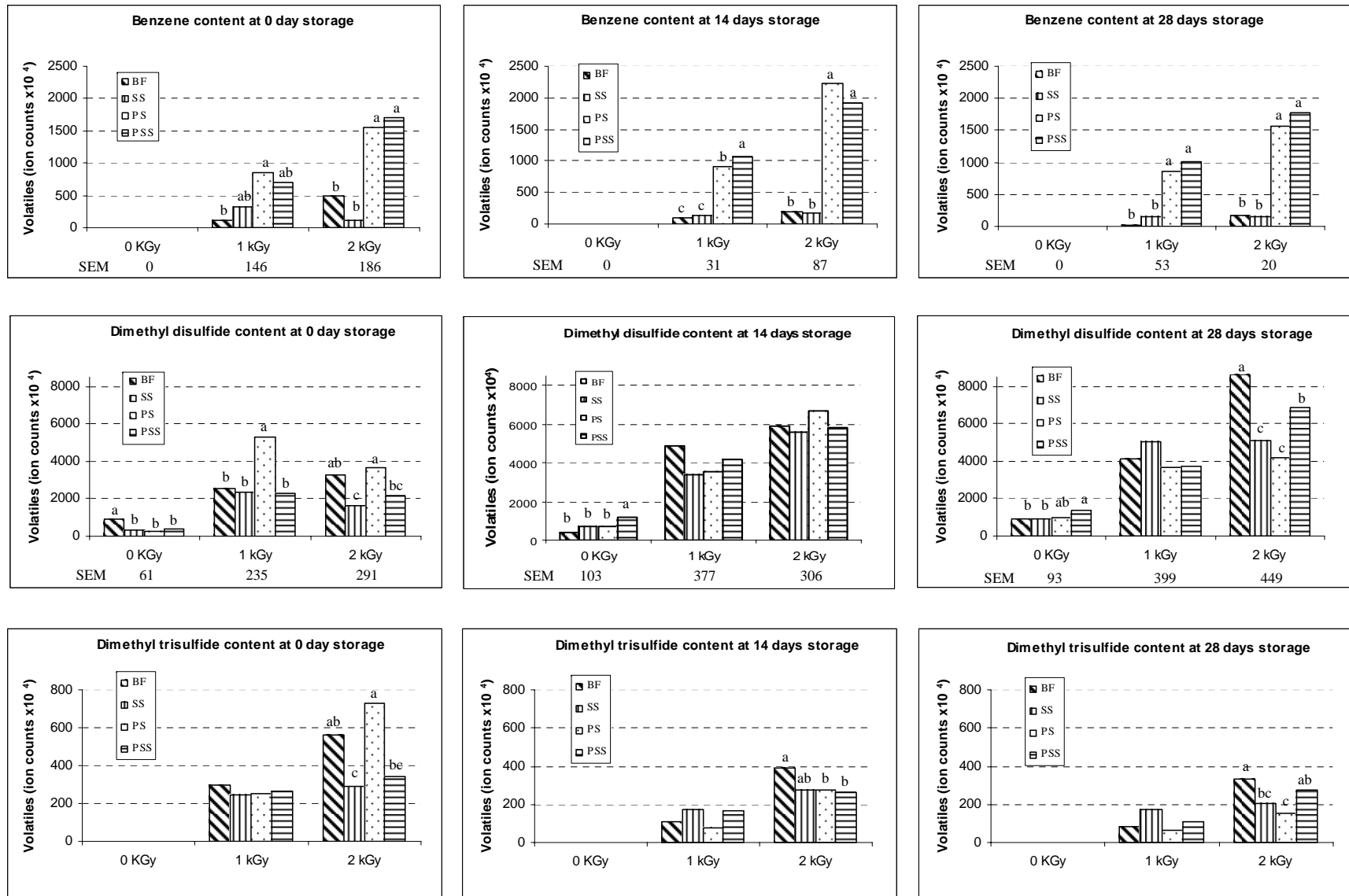


Figure 1. Benzene, dimethyl disulfide, and dimethyl trisulfide contents in the volatiles of irradiated breast rolls with or without antimicrobial additives (^{abc}Means within group with different superscript differ significantly ($P < 0.05$). $n = 4$, BF = basic formula, PS = including 0.1% potassium benzoate and 2% (W/W) sodium lactate, SS= including 2% sodium lactate and 0.1% sodium diacetate, PSS= including 0.1% potassium benzoate, 2% sodium lactate, and 0.1% sodium diacetate).