Effect of Antioxidants on Consumer Acceptance of Irradiated Turkey Meat

E.J. Lee, J. Love, and D.U. Ahn

ABSTRACT: Antioxidants had no effect on the production of sulfur compounds, color change, and off-odor intensity of irradiated turkey breast meat, but addition of sesamol + tocopherol or gallate + tocopherol was effective in reducing thiobarbituric acid-reactive substance values and aldehydes, especially under aerobic conditions. Consumers preferred the color of irradiated raw and cooked meat to nonirradiated meat because the pink color of irradiated meat looked fresher. The packaging method was more important than the antioxidant treatment in reducing irradiation off-odor because S-compounds produced by irradiation easily volatilized under aerobic packaging conditions. Therefore, the combined use of aerobic packaging and antioxidants is recommended to improve consumer acceptance of irradiated poultry meat.

Keywords: antioxidants, irradiation, packaging, turkey breast meat, consumer acceptance

Introduction

Irradiation technology has a great potential to be used by the meat industry as a tool to control pathogenic microorganisms in raw meat. The use of irradiation technology by the meat industry, however, is limited because of quality concerns such as off-odor and off-flavor production and color changes in meat by irradiation that significantly impact on consumer acceptance. Ionizing radiation is known to generate hydroxyl radicals that can degrade amino acids and lipids, and also produce various volatile compounds and carbon monoxide (CO) that induce off-odor and color changes in meat (Ahn 2002; Ahn and Lee 2002; Nam and Ahn 2002a, 2002b; Lee and Ahn 2003a, 2003b). The volatiles responsible for off-odor are sulfur compounds such as carbon disulfide, mercaptomethane, dimethyl sulfide, thioacetate S-methyl ester, and dimethyl disulfide generated by the radiolytic degradation of sulfur amino acids (Ahn and others 2001; Ahn 2002). Antioxidants such as free radical terminators or metal chelating agents are commonly used in meat to reduce lipid oxidation and improve sensory quality of cooked meat (Hsieh and Kinsella 1989; Chen and Ahn 1998). The pigment responsible for pinking in irradiated turkey breast was CO-myoglobin (Mb), and the changes of oxidation-reduction potential (ORP) in meat played an important role in the formation of CO-Mb (Nam and Ahn 2002a, 2002b). The major sources of CO in irradiated meat were meat components such as amino acids and phospholipids (Lee and Ahn 2003b). Our previous studies show that the addition of α-tocopherol + gallate or α-tocopherol + sesamol was effective in reducing off-odor volatiles, but had no effect on the redness of irradiated turkey patties (Nam and Ahn 2002b, 2003; Lee and Ahn 2003c).

More than 4000 stores are currently marketing irradiated ground beef products, and the consumption of irradiated meat is increasing very rapidly. However, consumer and industry response to irradiated poultry meat is lukewarm because of off-odor/off-flavor and color changes in irradiated meat after cooking (Olson 2003). Several reports indicated that positive attitudes toward irradiation are increasing (Bruhn 1995; Resurreccion and others 1995), and consumer education is very important for the acceptance of food irradiation (AMIF 1993). Most consumer studies on irradiated foods were carried out only using a questionnaire without presenting real irradiated products, and tests using real products are needed to determine actual consumer response to irradiated meat.

The objective of this study was to determine consumer acceptance of irradiated raw and cooked turkey breast meat with antioxidants added. The final consumer acceptance of irradiated meat can be determined by 2 factors: exterior color and odor characteristics of raw irradiated meat and the interior color and taste of irradiated meat after cooking. Therefore, finding consumer reactions to the color and odor characteristics of irradiated raw and cooked turkey meat with different packaging is critical to the use of irradiation technology by the poultry industry.

Materials and Methods

Sample preparation

Raw turkey breasts were purchased from 4 local grocery stores. The meats purchased from each grocery store were ground separately through a 3-mm plate and were treated as a replication. Gallate (3,4,5-trihydroxybenzoic acid) and sesamol (3,4-methylenedioxyphenol) were purchased from Sigma Chemical Co. (St. Louis, Mo., U.S.A.) and α-tocopherol from Aldrich Chemical Co. (Milwaukee, Wis., U.S.A.). Gallate and sesamol were dissolved in distilled water and stored at 4°C.

Nonirradiated and irradiated controls (no antioxidant added) and 2 antioxidant treatments (tocopherol + gallate, tocopherol + sesamol, 0.5 mM each, final concentration), which produced the least off-odor volatiles and lipid oxidation in our previous raw study (Lee and Ahn 2003c), were prepared. Patties (100 g) were prepared after adding an antioxidant treatment to ground meat and mixing for 3 min to ensure uniform distribution of antioxidants. Half of the patties from each treatment were individually packaged in polyethylene oxygen-permeable bags (Assoc. Bag Co., Milwaukee, Wis., U.S.A.), and the other half were vacuum-packaged in high-oxygen-barrier bags (nylon/polyethylene, 9.3 mL O₂/m²/24 h at 0°C; Koch, Kansas City, Mo., U.S.A.). All samples were irradiated at an average dose of 0 (control) or 3.0 kGy using a linear accelerator (Circe III; Thomson CSF Linac, Saint-Aubin, France). The energy and power level used were 10 MeV and 10 kW, respectively, and the average dose rate was...
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84.9 kGy/min. To confirm the target dose, 2 alanine dosimeters per cart were attached to the top surface and bottom surface of a sample vial. The alanine dosimeter was read using a 104 Electron Paramagnetic Resonance instrument (Bruker Instruments Inc., Billerica, Mass., U.S.A.). The max/min ratio was 1.21 (avg.). Consumer acceptance and chemical characteristics (lipid oxidation, volatile profiles, and color) of raw meat were determined after 4 d of storage at 4 °C. For the cooked meat study, vacuum-packaged or aerobically packaged patties were irradiated and stored at 4 °C for 4 d before cooking. Patties were cooked in an electric oven at 175 °C to an internal temperature of 78 °C. Internal temperatures of meat during cooking were monitored with thermocouples connected to digital read-out devices. All the cooked meat patties were vacuum-packaged immediately after cooking to minimize oxidative changes during storage and handling before consumer test. The cooked meats were refrigerated for less than 24 h before the consumer acceptance test. Volatiles, color, and lipid oxidation of cooked patties were also determined as in raw turkey meat.

Chemical analyses

A purge-and-trap apparatus (Solatek 72 and Concentrator 3100; Tekmar-Dohrmann, Cincinnati, Ohio, U.S.A.) connected to a gas chromatograph-mass spectrometer (GC-MS; Hewlett-Packard Co., Wilmington, Del., U.S.A.) was used to analyze volatiles produced. The conditions of the purge-and-trap apparatus and GC-MS were described by Lee and Ahn (2003c). The area of each peak was integrated using the ChemStation apparatus and GC-MS were described by Lee and Ahn (2003c). The area of each peak was integrated using the ChemStation apparatus and GC-MS were described by Lee and Ahn (2003c).

Esters 760 b 845 631 800 89
Ketones 13761b 15729ab 17519a 16580a 670
Aldehydes 741b 2288a 0b 183b 278
Sulfur compounds 998 b 25500a 24711a 21285a 3834
Esters 760 b 845 631 800 89
Total volatiles 177874 92791 78381 64114

C-nonIR, nonirradiated control; C-IR, irradiated control; S + Toc-IR, irradiated sesame and alpha-Tocopherol; G + Toc-IR, irradiated galate and alpha-Tocopherol; SEM, standard error of the means. n = 4. Cyclo-compounds: cyclocotene, toluene; Hydrocarbons: 1-heptane, hexane, octane, pentane; Ketones: 2-butanol, 2-heptanone, 2-propanone; Alcohol: 1-hexanol, 1-octen-3-ol, 1-penten-3-ol, 1-propanol, 2-butanol, 2-propanol, 3-methyl-1-butanol, ethanol; Aldehydes: nonanal, hexanal, 2-heptenal; Sulfur compounds: dimethyl disulfide, dimethyl trisulfide; Esters: ethyl ester acetic acid, methyl ester formic acid.

Values with different letters within a row are different (P < 0.05).

Consumer acceptance test

Adults who regularly consume turkey or chicken products were recruited for consumer acceptance tests for raw (99 participants) and cooked (83 participants) meats. The consumer test was approved by the university’s Human Subjects Committee and was conducted in the Sensory Evaluation Unit of the Center for Designing Foods to Improve Nutrition at Iowa State Univ. Raw turkey patties (8 treatments) were evaluated for the preference of exterior color and odor, and cooked turkey patties (7 treatments) were evaluated for the preference of interior color and flavor. Consumer acceptance was determined by asking the participants to indicate their degree of liking on a 9-point horizontal category scale with “dislike extremely” anchoring the left category and “like extremely” anchoring the right category. Demographic information such as gender, age, and level of education, and questions of consumption frequency of turkey or chicken products also were included in the questionnaire.

For the raw meat test, patties equilibrated at room temperature for 1 h were presented in sealed packages to the participants. Equilibration of meat at room temperature before sensory testing was done to increase the likelihood of detection of off-odors. After rating the color by marking a category on a paper ballot, participants were instructed to cut open the bag, smell the sample, and indicate their opinion of the odor. For the cooked meat test, cooked patties were warmed in a microwave oven (Amana Radarange, Amana, Iowa, U.S.A.). Meats were cooked the previous day because cooking and consumer testing simultaneously was impossible. Cooked meats were vacuum-packaged in high-oxygen-barrier bags (nylon/polyethylene, 9.3 mL O2/m2/24 h at 0 °C; Koch) while the meat was still hot to optimize oxidative changes in cooked meat (Ahn and others 1992). Three patties were warmed on a plate that was rotated at 40-s intervals for a total of 120 s of heating. Patties were placed in preheated (77 °C) covered casserole dishes. The heated patties were cut into quarters and each participant received 1 piece in a covered polyfoam container labeled with a random 3-digit code. For scoring the cooked samples, a computerized system (Compusense five, v. 4.0; Compusense, Inc., Guelph, Ontario, Canada) was used. Participants were instructed to rinse their mouths with water before starting to taste, and also between samples. Samples were evaluated in partitioned booths under fluorescent lighting conditions (70 foot-candles at the surface of the counter). A complete block design was used for each of the tests. Serving order was randomized.

Statistical analysis

Data were analyzed using the General Linear Model procedure of SAS software (SAS Inst. 1995); Student-Newman-Keul’s multiple range test was used to compare the mean values among antioxidant treatments. Mean values and standard error of the means (SEM) were reported. Signifi-

### Table 1—Volatile compounds of raw turkey breast meat patties with different antioxidants added

<table>
<thead>
<tr>
<th>Volatiles</th>
<th>C-nonIR</th>
<th>C-IR</th>
<th>S + Toc-IR</th>
<th>G + Toc-IR</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclo-compounds</td>
<td>270°</td>
<td>114°</td>
<td>649°</td>
<td>640°</td>
<td>123</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>354°</td>
<td>546°</td>
<td>173°</td>
<td>152°</td>
<td>438</td>
</tr>
<tr>
<td>Ketones</td>
<td>21581</td>
<td>25100</td>
<td>22584</td>
<td>20511</td>
<td>1273</td>
</tr>
<tr>
<td>Alcohols</td>
<td>273831a</td>
<td>27475</td>
<td>18001b</td>
<td>16425b</td>
<td>5831</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>1278°</td>
<td>5043</td>
<td>1291°</td>
<td>898°</td>
<td>730</td>
</tr>
<tr>
<td>Sulfur compounds</td>
<td>0 b</td>
<td>171a</td>
<td>0 b</td>
<td>0 b</td>
<td>13</td>
</tr>
<tr>
<td>Esters</td>
<td>21236e</td>
<td>2288b</td>
<td>2090°</td>
<td>1940°</td>
<td>1777</td>
</tr>
<tr>
<td>Total volatiles</td>
<td>321739</td>
<td>66691</td>
<td>46344</td>
<td>41938</td>
<td></td>
</tr>
</tbody>
</table>

C-nonIR, nonirradiated control; C-IR, irradiated control; S + Toc-IR, irradiated sesame and alpha-Tocopherol; G + Toc-IR, irradiated galate and alpha-Tocopherol; SEM, standard error of the means. n = 4. Cyclo-compounds: cyclocotene, toluene; Hydrocarbons: 1-heptane, hexane, octane, pentane; Ketones: 2-butanol, 2-heptanone, 2-propanone; Alcohol: 1-hexanol, 1-octen-3-ol, 1-penten-3-ol, 1-propanol, 2-butanol, 2-propanol, 3-methyl-1-butanol, ethanol; Aldehydes: nonanal, hexanal, 2-heptenal; Sulfur compounds: dimethyl disulfide, dimethyl trisulfide; Esters: ethyl ester acetic acid, methyl ester formic acid. Values with different letters within a row are different (P < 0.05).
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Table 2—TBARS and CIE color values of raw turkey breast meat patties with different antioxidants added

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Clinical</th>
<th>CIE color values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L* value</td>
<td>a* value</td>
</tr>
<tr>
<td></td>
<td>Aero.</td>
<td>Vac.</td>
</tr>
<tr>
<td>Control (0 kGy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (3 kGy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sesamol + Tocopherol (3 kGy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gallate + Tocopherol (3 kGy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEM 0.06</td>
<td>0.35</td>
<td>0.40</td>
</tr>
</tbody>
</table>

C-nonIR, nonirradiated control; C-IR, irradiated control; S + Toc-IR, irradiated sesamol and /alpha/-tocopherol; G + Toc, irradiated gallate and /alpha/-tocopherol; Aero., aerobic package; Vac., vacuum package; SEM, standard error of the means. n = 4.

Results and Discussion

Effect of antioxidants on raw turkey breast meat

Irradiation, antioxidants, and packaging methods influenced the amounts and profiles of volatiles of raw turkey breast patties (Table 1). With aerobic packaging, greater amounts of alcohols and esters were produced in nonirradiated than irradiated meats. It seems that the growth of microorganisms during the 4-d storage before chemical analyses affected the increase of these volatiles in nonirradiated meat (data not shown). Aldehydes, hydrocarbons, and cyclo-compounds increased after irradiation, and antioxidants were effective in reducing these volatiles. Small amounts of sulfur compounds, which are known to cause irradiation off-odor (Ahn and others 2000a), were detected only in the irradiated control after 4 d of storage under aerobic packaging conditions. With vacuum-packaging, irradiation generated many sulfur compounds such as dimethyl disulfide and dimethyl trisulfide in turkey breast meat. This confirmed our previous results that S-compounds produced by irradiation volatilized rapidly under aerobic packaging conditions (Nam and others 2002; Nam and Ahn 2003). Antioxidants had no effect in reducing the amounts of sulfur compounds in vacuum-packaged meat, but were effective in reducing the production of lipid-oxidation-dependent volatiles, especially hexanal.

TBARS values of turkey breast meat patties were affected by irradiation, antioxidant, and packaging methods (Table 2): irradiation increased TBARS values, and aerobically packaged control meat had higher TBARS values than vacuum-packaged control meat. Antioxidant treatments were effective in controlling lipid oxidation of both aerobically packaged and vacuum-packaged turkey patties. Ahn and others (1997) reported that irradiation increased lipid oxidation in raw turkey breast and thigh meats that were aerobically packaged. Chen and others (1999) reported that phenolic antioxidants were effective in reducing lipid oxidation in aerobically packaged irradiated turkey meats at Day 0. No difference in TBARS values between antioxidant treatments was found (Table 2).

Irradiation increased the redness (a* value) of turkey breast meat, and the a* values of vacuum-packaged turkey breast meats were higher than those of aerobically packaged meats (Table 2). Luchinger and others (1996) reported that increased red color in irradiated pork was more intense and stable with vacuum-packaging than aerobic conditions during refrigerated storage. The lightness (L* value) and yellowness (b* value) of irradiated turkey breast in aerobic conditions were also higher than those in vacuum conditions. Antioxidant treatments had no effect on the color of irradiated raw turkey breast meat (Table 2).

The results of the consumer acceptance test of raw turkey breast meat patties with different antioxidants added are shown in Table 4. Most panelists were female (73%), between the ages of 18 and 34 (80%), who consumed turkey or chicken products once a week or more (66%) (Table 3). The percentage of females seemed rather high. However, FMI (1994) reported that the primary food shopper was female (59%) and only 13% of the primary shoppers were male.

Consumers easily distinguished odor differences between nonirradiated and irradiated turkey patties. Ahn and others (2000b) described the irradiation odor from irradiat-
ed turkey as “barbecued corn-like.” For consumer preference of meat odor, nonirradiated turkey meat patties were superior to vacuum-packaged meats. This result agrees with the data for volatiles, in which irradiation increased sulfur compounds but the sulfur volatiles disappeared rapidly under aerobic packaging conditions (Table 1). Antioxidants had no significant effect on the off-odor intensity of irradiated turkey breast meat in the consumer acceptance test, even though previous data showed that antioxidants reduced the amounts of off-odor volatiles significantly (Lee and Ahn 2003c). Consumers preferred the color of irradiated control breast patties to nonirradiated control patties. We believe that consumers preferred the pink color of raw meat after irradiation because it looked fresher than nonirradiated meat. No difference in color preference was observed between irradiated control and antioxidant-treated irradiated meats. This indicated that antioxidant had little effect on the redness of irradiated meat. The aerobically packaged, irradiated raw turkey breast meats with added sesamol + tocopherols showed the lowest consumer preference because the addition of sesamol made the color dull red. However, consumer liked the color of irradiated turkey breast meat with added sesamol + tocopherols when they were vacuum-packaged. This agrees with the result of the CIE color analysis (Table 2).

### Table 5—Volatile compounds of cooked turkey breast meat patties with different antioxidants added

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Cyclo-compounds&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1921&lt;sup&gt;d&lt;/sup&gt;</td>
<td>4174&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9429&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2651&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>3212&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>3316&lt;sup&gt;bcd&lt;/sup&gt;</td>
<td>4493&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>42434&lt;sup&gt;b&lt;/sup&gt;</td>
<td>59335&lt;sup&gt;b&lt;/sup&gt;</td>
<td>148512&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28622&lt;sup&gt;b&lt;/sup&gt;</td>
<td>41890&lt;sup&gt;b&lt;/sup&gt;</td>
<td>33909&lt;sup&gt;b&lt;/sup&gt;</td>
<td>59192&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ketones</td>
<td>19211&lt;sup&gt;b&lt;/sup&gt;</td>
<td>21253&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>24705&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16795&lt;sup&gt;b&lt;/sup&gt;</td>
<td>19898&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>4304&lt;sup&gt;c&lt;/sup&gt;</td>
<td>20331&lt;sup&gt;ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Alcohols</td>
<td>21320&lt;sup&gt;d&lt;/sup&gt;</td>
<td>32716&lt;sup&gt;a&lt;/sup&gt;</td>
<td>26318&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20996&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>18102&lt;sup&gt;c&lt;/sup&gt;</td>
<td>21257&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>18124&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>22664&lt;sup&gt;b&lt;/sup&gt;</td>
<td>77940&lt;sup&gt;a&lt;/sup&gt;</td>
<td>76250&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9801&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6189&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6657&lt;sup&gt;b&lt;/sup&gt;</td>
<td>11936&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sulfur compounds</td>
<td>927&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1555&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12359&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1374&lt;sup&gt;c&lt;/sup&gt;</td>
<td>13308&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1075&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6968&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total volatiles</td>
<td>108550&lt;sup&gt;a&lt;/sup&gt;</td>
<td>196973&lt;sup&gt;a&lt;/sup&gt;</td>
<td>297572&lt;sup&gt;a&lt;/sup&gt;</td>
<td>80238&lt;sup&gt;b&lt;/sup&gt;</td>
<td>102599&lt;sup&gt;a&lt;/sup&gt;</td>
<td>70518&lt;sup&gt;b&lt;/sup&gt;</td>
<td>121045&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup>Cyclo-compounds: 4-1,1-dimethylethyl cyclohexanol, cycloheptene, cyclopentane, toluene; Hydrocarbons: 1-heptane, 1-heptene, 1-pentene, 2,2,5-trimethyl hexane, 2,2,7,7-tetramethyl octane, 2,4,6-trimethyl octane, 2,5,6-trimethyl octane, 2,6,10-trimethyl dodecane, 2,6,7-trimethyl decane, 2,7,10-trimethyl dodecane, 2-methyl butane, 2-methyl decane, 2-methyl undecane, 2-octene, 3,3,7-trimethyl decane, 3,5-dimethyl octane, 3,7-dimethyl nonane, 3-methyl decane, 3-methyl dodecane, 3-methyl undecane, 4,8-dimethyl undecane, 4-methyl decane, 5,6-dimethyl decane, 5-methyl undecane, butane, decane, dodecane, heptane, hexane, nonane, octacosane, octadecane, octane, pentane, undecane; Ketones: 2-butane, 2-propanone; Alcohols: ethanol, 1-octen-3-ol, 1-pentanol, 1-penten-3-ol, 1-propanol, 2-butanol, 2-propanol; Aldehydes: 2-methyl butanal, 2-methyl propanal, 3-methyl butanal, aldehyde, heptanal, hexanal, nonanal, pentanal, propanal; Sulfur compounds: carbon disulfide, dimethyl disulfide, methanethiol.

### Table 6—TBARS, CIE color values, and consumer acceptance test of cooked turkey breast meat patties with different antioxidants added

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TBARS</td>
<td>0.60&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.35&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.35&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.46&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>0.41&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup>Values with different letters within a row are different (P < 0.05).

### Effect of antioxidants on cooked turkey breast meat

Irradiation increased aldehydes, but antioxidants were effective in reducing aldehydes in both aerobically packaged and vacuum packaged cooked turkey breast meat (Table 5). Aldehydes contribute to the oxidation flavor (rancidity) of cooked meat the most, and hexanal is the predominant aldehyde in cooked meat (Shahidi and Pegg 1994). Under vacuum conditions, many cyclo-compounds, hydrocarbons, and sulfur compounds were produced by irradiation. Antioxidant treatments reduced the amount of cyclo-compounds and hydrocarbons in vacuum packaged, cooked turkey breast meat. The amounts of sulfur compounds in irradiated, cooked turkey breast meats, which were stored in aerobic conditions before cooking, were much lower than those stored in vacuum conditions. This indicated that packaging conditions were more important than antioxidant treatments in reducing irradiation off-odor. Although many sulfur compounds were detected in vacuum-packaged cooked turkey meat, the amounts of S-compounds in cooked meat were lower than those in raw meat, indicating that large proportions of S-compounds were volatilized during cooking and subsequent handling. Gallate + tocopherol treatment was the best in reducing the amount of S-compounds of cooked turkey breast meat under vacuum conditions.

Irradiation increased TBARS values, but all antioxidant treatments were effective in reducing lipid oxidation of cooked turkey breast patties, both with aerobic and vacuum packaging (Table 6). This result agrees with that of the effect of antioxidants, which reduced the amounts of aldehydes in cooked turkey meat patties (Table 5). Ahn and others (1997, 1998) reported that the use of antioxidants such as ascorbate, citrate, tocopherol, gallate esters, and polyphenols was effective in reducing off-odor of irradiated meat.
effective in reducing the α* value of irradiated cooked turkey breast meat except for vacuum-packaged meat with sesamol + tocopherol treatment (Table 6).

The demographics of consumer panelists for cooked turkey breast meat were similar to those of the raw meat study: 75% of consumer panelists were female, 90% were between 18 and 54 y old, and 75% consumed turkey or chicken products once a week or more often (Table 3). Consumers could not distinguish odor differences between non-irradiated and irradiated cooked turkey meat because of a relatively large number of sulfur compounds were volatilized during cooking (Table 6). No differences in off-flavor were observed between the irradiated control and antioxidant-added irradiated meats. Consumers liked the interior color of vacuum-packaged cooked turkey breast meat with added sesamol + tocopherol, which produced the most red meat samples among all treatments. We have not specifically asked consumers why they liked certain meat better than others, but we believe that consumer liked the vacuum-packaged cooked turkey breast meat with added sesamol + tocopherol because this meat showed fresh-looking color.

Conclusions

The use of free radical scavengers reduced the amounts of aldehydes but had no effect on sulfur compounds in irradiated turkey meat. Packaging method was more important than antioxidant treatment in reducing irradiation off-flavor in raw samples because S-compounds produced by irradiation easily volatilized under aerobic packaging conditions. Antioxidants were effective in controlling oxidative change in irradiated turkey breast meat. The combined use of aerobic packaging and antioxidants was effective in reducing sulfur volatiles and lipid oxidation of raw meat, which improved consumer acceptance of irradiated raw poultry meat. However, the combined effect of packaging and antioxidants on the flavor and color of cooked turkey breast meat was not clear as in raw meat.

References

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