

# Antioxidant Properties of Far Infrared-Treated Rice Hull Extract in Irradiated Raw and Cooked Turkey Breast

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### Summary and Implications

The antioxidant effect of far-infrared-treated rice hull (FRH) extracts in irradiated turkey breast meat was compared with that of sesamol and rosemary oleoresin. FRH significantly decreased TBARS values and volatile aldehydes (hexanal, pentanal, and propanal) and was effective in reducing the production of dimethyl disulfide responsible for irradiation off-odor in irradiated raw and cooked turkey meat during aerobic storage. The antioxidant activity of FRH (0.1%, w/w) was as effective as that of rosemary oleoresin (0.1%). However, the addition of FRH increased red and yellow color intensities and produced an off-odor characteristic to rice hull in raw and cooked meat, and cannot be used in meat without further refining process to remove off-color and off-odor compounds.

### Introduction

Phenolic compounds such as sesamol, gallic acid, or tocopherol, singly or in combination to turkey meat or pork prevented quality changes in the meat by irradiation. Rice hull can be an attractive protective source because it contains many antioxidant compounds, which can be extracted easily. Furthermore, radiation of rice hull with far-infrared (FIR) for 2 hr increased the content of phenolic compounds in extract the DPPH radical scavenging activity, and the inhibited lipid peroxidation. FIR radiation onto rice hull is reported to liberate and activate covalently bound phenolic compounds that have antioxidant activities. Therefore, rice hull extract treated by FIR can be a good candidate to be used in irradiated meat systems as a natural antioxidant.

### Materials and Methods

Ground rice hulls were irradiated using a FIR heater for 2 h. FIR-treated rice hulls was extracted with methanol. Turkey breast muscles were ground through a 3-mm plate. Six treatments were prepared using irradiation and antioxidant combinations. Breast patties were individually packaged in oxygen-permeable bags, and irradiated at 2.5 kGy. Color, lipid oxidation, sensory and volatile production of raw and cooked meat were measured.

### Results and Discussion

Far infrared-radiated rice hull extracts (FRH) showed significant antioxidant activities in both irradiated raw and cooked turkey breast (Table 1). Irradiated meat became more susceptible to lipid oxidation than nonirradiated meat and the difference was more significant after storage and cooking. Due to the characteristic brown color of extracts, the incorporation of FRH and rosemary oleoresin both increased a-values of irradiated raw turkey breast (Table 2). Therefore, to increase the applicability of FRH as an antioxidant, the color should be removed from the FRH.

Irradiation produced many new volatiles but the production of volatile sulfur compounds was the most critical. Dimethyl disulfide (DMDS) and dimethyl sulfide (DMS) were the predominant volatiles in irradiated raw turkey meat. Addition of antioxidants significantly reduced the amount of off-odor volatiles in irradiated meat and lipid oxidation-dependent volatiles and hydrocarbons in irradiated raw turkey meat were significantly decreased. After 5 d of aerobic storage, the most prevalent volatile compounds in irradiated raw turkey breast were not sulfur-volatiles but 2-propanone and hexanal. Thus, more concern in aerobically stored meat was the production of lipid oxidation products such as aldehydes, which produce a rancid off-odor. Added antioxidants significantly reduced the development of lipid oxidation, and propanal and hexanal were not produced in meats with antioxidants added. The cooked irradiated turkey breast stored for 3 d produced greater amounts of volatile aldehydes than the meat stored for 0 d.

In raw meat, sensory panelists could not detect a significant difference in the intensities of irradiation odor (Table 3). On the other hand, panelists could easily distinguish rancid odor in irradiated raw and cooked turkey breast meat.

### Conclusion

Far-infrared-treated rice hull extracts (FRH) added in irradiated turkey meat at 0.1% showed a similar level of antioxidant activities to sesamol (pure phenolic) at 0.01% or commercial rosemary oleoresin at the 0.1% level. FRH effectively reduced the production of TBARS, volatile aldehydes, and volatile sulfur compounds in irradiated raw and cooked turkey meat. Turkey breast with FRH incorporated, however, had increased color intensity and produced a characteristic off-odor. Therefore, color and off-odor compounds should be removed from FRH if it is going to be used in meat as an antioxidant.

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**Table 1. TBARS values of irradiated raw and cooked turkey breast with different antioxidants**

| Storage                   | Nonir              | Irradiated         |                     |                     |                               | SEM                |      |
|---------------------------|--------------------|--------------------|---------------------|---------------------|-------------------------------|--------------------|------|
|                           | Control            | Control            | Sesamol<br>0.01%    | Rosemary<br>0.1%    | FRH <sup>1</sup><br>0.1% 0.2% |                    |      |
| <i>Raw</i>                |                    |                    |                     |                     |                               |                    |      |
| Day 0                     | 0.45 <sup>by</sup> | 0.52 <sup>ay</sup> | 0.24 <sup>c</sup>   | 0.23 <sup>c</sup>   | 0.25 <sup>c</sup>             | 0.28 <sup>c</sup>  | 0.02 |
| Day 5                     | 0.57 <sup>bx</sup> | 1.38 <sup>ax</sup> | 0.21 <sup>c</sup>   | 0.21 <sup>c</sup>   | 0.23 <sup>c</sup>             | 0.30 <sup>c</sup>  | 0.04 |
| <i>Cooked<sup>2</sup></i> |                    |                    |                     |                     |                               |                    |      |
| Day 0                     | 1.76 <sup>by</sup> | 2.81 <sup>ay</sup> | 0.52 <sup>cdy</sup> | 0.60 <sup>cdy</sup> | 0.76 <sup>cy</sup>            | 0.37 <sup>dy</sup> | 0.08 |
| Day 3                     | 3.53 <sup>bx</sup> | 4.74 <sup>ax</sup> | 1.21 <sup>dx</sup>  | 2.31 <sup>cx</sup>  | 2.02 <sup>cx</sup>            | 1.05 <sup>dx</sup> | 0.11 |

<sup>1</sup>Far-infrared-radiated rice hull extract. <sup>2</sup>0 d and 3 d after cooking

**Table 2. CIE color values of irradiated raw and cooked turkey breast with different antioxidants**

| Storage                    | Nonir              | Irradiated          |                    |                    |                               | SEM                 |     |
|----------------------------|--------------------|---------------------|--------------------|--------------------|-------------------------------|---------------------|-----|
|                            | Control            | Control             | Sesamol<br>0.01%   | Rosemary<br>0.1%   | FRH <sup>1</sup><br>0.1% 0.2% |                     |     |
| <i>Raw meat</i>            |                    |                     |                    |                    |                               |                     |     |
| ----- <i>L-value</i> ----- |                    |                     |                    |                    |                               |                     |     |
| Day 0                      | 51.4               | 52.2                | 51.9               | 52.1               | 52.0                          | 51.1 <sup>y</sup>   | 0.4 |
| Day 5                      | 51.2 <sup>c</sup>  | 52.0 <sup>abc</sup> | 51.7 <sup>bc</sup> | 52.9 <sup>a</sup>  | 52.8 <sup>a</sup>             | 52.4 <sup>abx</sup> | 0.3 |
| ----- <i>a-value</i> ----- |                    |                     |                    |                    |                               |                     |     |
| Day 0                      | 6.6 <sup>dx</sup>  | 7.8 <sup>bx</sup>   | 7.0 <sup>cx</sup>  | 8.4 <sup>ax</sup>  | 8.3 <sup>ax</sup>             | 8.4 <sup>ax</sup>   | 0.1 |
| Day 5                      | 4.3 <sup>cy</sup>  | 6.0 <sup>by</sup>   | 3.8 <sup>dy</sup>  | 6.1 <sup>by</sup>  | 6.4 <sup>ay</sup>             | 6.6 <sup>ay</sup>   | 0.1 |
| <i>Cooked Meat</i>         |                    |                     |                    |                    |                               |                     |     |
| ----- <i>L-value</i> ----- |                    |                     |                    |                    |                               |                     |     |
| Day 0                      | 84.7 <sup>ab</sup> | 84.2 <sup>bc</sup>  | 84.9 <sup>a</sup>  | 84.1 <sup>bc</sup> | 83.6 <sup>c</sup>             | 82.7 <sup>d</sup>   | 0.2 |
| Day 3                      | 84.3 <sup>ab</sup> | 84.4 <sup>ab</sup>  | 84.8 <sup>a</sup>  | 84.2 <sup>ab</sup> | 83.9 <sup>b</sup>             | 82.7 <sup>c</sup>   | 0.2 |
| ----- <i>a-value</i> ----- |                    |                     |                    |                    |                               |                     |     |
| Day 0                      | 5.7 <sup>ax</sup>  | 5.3 <sup>bx</sup>   | 5.3 <sup>b</sup>   | 5.2 <sup>bx</sup>  | 5.6 <sup>ax</sup>             | 5.7 <sup>a</sup>    | 0.1 |
| Day 3                      | 5.0 <sup>cdy</sup> | 4.6 <sup>ey</sup>   | 5.3 <sup>b</sup>   | 4.9 <sup>dy</sup>  | 5.2 <sup>bey</sup>            | 5.9 <sup>a</sup>    | 0.1 |

<sup>1</sup>Far-infrared-radiated rice hull extract. <sup>2</sup>0 d and 3 d after cooking.

**Table 3. Sensory characteristics of irradiated raw and cooked turkey breast with different antioxidants**

| Off-odor <sup>1</sup>   | Control           | Sesamol<br>0.01% | Rosemary<br>0.1% | FRH <sup>2</sup><br>0.1% | SEM |
|-------------------------|-------------------|------------------|------------------|--------------------------|-----|
| <i>Irradiation odor</i> |                   |                  |                  |                          |     |
| Raw at 5 d              | 5.3               | 3.3              | 1.3              | 1.4                      | 1.2 |
| Cooked at 0 d           | 3.2               | 6.7              | 2.4              | 3.1                      | 1.2 |
| Cooked at 3 d           | 4.4               | 4.7              | 6.3              | 3.9                      | 2.0 |
| <i>Rancid odor</i>      |                   |                  |                  |                          |     |
| Raw at 5 d              | 11.5 <sup>a</sup> | 3.4 <sup>b</sup> | 2.3 <sup>b</sup> | 4.8 <sup>b</sup>         | 1.0 |
| Cooked at 0 d           | 11.9 <sup>a</sup> | 4.8 <sup>b</sup> | 3.9 <sup>b</sup> | 5.3 <sup>b</sup>         | 1.2 |
| Cooked at 3 d           | 12.9 <sup>a</sup> | 3.0 <sup>b</sup> | 4.9 <sup>b</sup> | 3.0 <sup>b</sup>         | 0.7 |

<sup>1</sup>0.0: not detectable, 15.0: highly intense. <sup>2</sup>Far-infrared-radiated rice hull extract.