EFFECT OF TOCOPHEROL ADDITION ON SECONDARY LIPID OXIDATION PRODUCTS IN IRRADIATED GROUND BEEF

W. P. Hanson[1,2], D. U. Ahn[1], D. G. Olson[1,2]

[1]Department of Animal Science, Iowa State University, Ames IA 50011, USA
[2]Department of Food Science and Human Nutrition, Iowa State University, Ames IA 50011, USA

Background:
Irradiation of ground beef is an effective means for controlling bacterial pathogens. Unfortunately, meat irradiation results in off-odors. Such odors have previously been attributed to an increase in lipid oxidation (*Huber et al., 1953*). Ju et al. (*1999*). reported that antioxidants reduced TBA values of irradiated ground beef . TBA or TBARS values have traditionally been used to measure lipid oxidation. However, a more accurate way to determine the role of lipid oxidation on irradiated meat odor is to measure volatile secondary products of oxidation. Alkanes and aldehydes, particularly pentane and hexanal, correlate well with lipid oxidation (*Frankel, 1982*). If such products found in irradiated meat were solely the result of lipid oxidation, addition of an antioxidant should reduce their levels.

Objective:
The objective of this experiment was to determine the effect of tocopherol addition on the levels of volatile alkanes and aldehydes produced by the irradiation of ground beef.

Methods:
Coarse ground beef (81% lean) was ground through a 1/8-inch plate. Meat was either mixed with a 500 ml solution of mixed tocopherols (α, β, γ, δ) to a final concentration of 300 ppm, or mixed with water alone. Patties (113.5 kg) were formed and irradiated by electron beam to a dose of 0 or 4.5 kGy. Immediately following irradiation, samples for day 0 analysis were vacuum packaged in oxygen barrier film. Day 5 patties were stored in oxygen permeable overwrap at 0°C. Volatile analysis was carried out by purge and trap GC/ MS using a method similar to that of Ahn et al. (*2000*). All unbranched alkanes and aldehydes appearing in the chromatogram were analyzed by ANOVA. Alkanes utilized for analysis included butane, pentane, hexane, heptane, octane, and nonane. Butanal, pentanal, hexanal, and octanal were the aldehydes subjected to analysis. Heptanal was omitted due to poor chromatographic separation. The experiment was replicated four times.

Results:
Alkanes: Irradiation to 4.5 kGy increased the concentrations of all alkanes ($p < 0.05$). Hexane, heptane, and octane levels increased at day five for irradiated, but not for unirradiated samples ($p < 0.05$). Concentration of pentane increased significantly ($p < 0.05$) with storage. Tocopherol reduced pentane levels ($p < 0.05$), however, this effect was seen only after storage.
Adehydes: Concentration of butanal, pentanal, hexanal, and octanal increased with irradiation ($p < 0.05$). Pentanal levels increased with storage. After 5 days of storage, irradiated samples without tocopherol had higher hexanal concentrations ($p< 0.05$) than all other samples (Figure 1).

Figure 1. – Hexanal peak area (ion counts x 1000)

Treatment		Hexanal – Day 0	Hexanal – Day 5
Irradiated (4.5 kGy)	No tocopherol	1817[a]	23539[x]
	300 ppm tocopherol	957[a]	4517[y]
Unirradiated	No tocopherol	undetectable	1504[y]
	300 ppm tocopherol	undetectable	419[y]

[a, x-y] Values within a column with different superscript letters are significantly different ($p < 0.05$)

Conclusions:
The addition of tocopherol to ground beef did little to retard production of volatile alkanes and aldehydes upon irradiation. Pentane and hexanal were the only volatiles measured that exhibited a significant reduction with the addition of tocopherol. In both instances, tocopherol only affected volatiles after five days of storage. The results suggest that initial (day 0) irradiation odor would not be reduced by the addition of tocopherol. Ahn et al. (*2000*) speculated that sulfur compounds play more of a role in irradiated meat odor than lipid oxidation products. Our study also suggests that lipid oxidation does not sufficiently explain initial irradiation odor. Sensory panel work is needed to validate this result.

Pertinent Literature:
Ahn, D.U., Jo, C., and Olson, D.G. 2000. Analysis of volatile components and the sensory characteristics of irradiated raw pork. Meat Sci. 54: 209-215.
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Ju, W.L., Hong, S.Y., Seong, A.K., Kyong, H.L., and Myung, W.B. 1999. Effects of antioxidants and gamma irradiation on the shelf life of beef patties J. Food Prot. 62: 619-624.