

REDUCTION OF CHOLESTEROL AND LIPID OXIDATION IN RADIATION DECONTAMINATED MECHANICALLY DEBONED TURKEY MEAT

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Background

Mechanically deboned poultry meats are increasingly utilized for certain meat products. Processing by ionizing radiation is one of the most efficient non-thermal technologies for elimination of non-sporeforming pathogenic bacteria associated with these commodities. Radiation decontamination of frozen blocks of mechanically deboned poultry meat is an established commercial technology since several years in France (Sadat and Volle, 2000) and irradiation of beef patties has been recently implemented in the United States (Mermelstein, 2000). However, irradiation may induce non-desirable oxidative changes of lipids and cholesterol (Hwang and Maerker, 1993). Cholesterol oxidation products (COPs) are reported to be potentially atherogenic, cytotoxic, mutagenic, carcinogenic, may cause membrane damage, and can inhibit the cholesterol biosynthesis (Chizzolini et al., 1998). Natural antioxidants can be effective in inhibiting these unwanted changes of processed and gamma-irradiated meat.

Objectives

The aim of this work was to study the effect of 3 kGy ionizing radiation treatment on microbiological status as well as lipid oxidation and cholesterol oxidation of mechanically deboned turkey meat as affected by the addition of natural antioxidants such as thyme oil or a combination of α -tocopherol and ascorbic acid (AsH) under aerobic packaging condition which supports oxidative changes.

Methods

Mechanically deboned turkey meat obtained in frozen state from a poultry processing plant was thawed and divided into three experimental batches: 1) without antioxidants; 2) with addition of 250 mg/100 g thyme-oil, and 3) with addition of 12 mg α -tocopherol/100 g plus 25 mg ascorbic acid/100 g sample. Replicate samples of approx. 25 g each were sealed without evacuation into small pouches of „Multiseven” PE-PA laminated foil and half of the batches were treated with a dosage level of 3 kGy in a Co-60 self-shielded radiation source, type RH- γ -30 at a dose rate of 2.73 kGy/h at approx. 5 °C, then stored together with respective unirradiated samples at 4 °C for 15 days.

Microbiological examinations, determination of cholesterol oxides and measurement of thiobarbituric acid-reactive substances (TBARS-values) as indices of lipid oxidation were carried out with duplicate samples at 0 and 15 days. Total aerobic viable cell counts (TVCs) in TGE plates (Merck 1.05463) and Enterobacteriaceae counts on VRBG agar (Oxoid CM485) were estimated. Sample preparation for COPs analysis included lipid extraction, saponification and separation of nonsaponifiable fraction. Determination of COPs were performed by combination of high-performance thin-layer (Merck HPTLC Kieselgel 60 F₂₅₄) chromatographic separation of individual oxidized cholesterol derivatives and measurement of scraped and eluted spots by an enzymatic method based on the reaction of cholesterol oxidase (Lebovics et al. 1996). The TBARS values were estimated according to Ramanathan and Das (1993) and expressed as malondialdehyde.

Results and discussion

Radiation treatment reduced the TVC by 3.5 log units (from log N/g=4.75 to log N/g=1.20) and the Enterobacteriaceae count from log N/g=4.1 to below the detection limit (log N/g<1.0) as estimated directly after treatment (0 day) in the antioxidant-free samples. In the thyme oil-containing samples the residual TVC at 0 day was log N/g=1.6 whereas log N/g=2.0 in the tocopherol-AsH-containing samples. Residual Enterobacteriaceae counts were less than the above detection limit in all irradiated samples containing antioxidants.

During 15 days of chilled storage, unirradiated samples reached a spoilage level of TVCs (log N/g= 8.75), and an Enterobacteriaceae level of log N/g=8.3, independent of the presence or absence of antioxidants. No growth of the surviving bacteria occurred in the irradiated samples during the same period of storage. According to the relevant literature, non-sporeforming pathogenic bacteria showed decimal reduction doses (D₁₀ values as follows: 0.19 kGy for *Campylobacter jejuni*, 0.41 kGy for *Staphylococcus aureus*, 0.5 kGy for *Listeria monocytogenes* and 0.71 kGy for *Salmonella* spp., respectively, in turkey meat or mechanically deboned turkey meat irradiated at 5 °C (Lambert and Maxcy, 1984; Thayer et al., 1995).

Results of COPs and TBARS measurements are presented in Tables 1 and 2, respectively. Several COPs, such as 7 α -hydroxycholesterol, 7 β -hydroxycholesterol, and cholesterol-5 α ,6 α -epoxide were found even in the unirradiated samples before irradiation and storage. Gamma irradiation enhanced the cholesterol and lipid oxidation (causing approx. 20 % increase in the COPs level, and 50 % increase in TBARS values at 0 day in the antioxidant-free samples. 15 day storage did not cause an increase in COPs level. In irradiated samples without addition of antioxidants. The presence of antioxidants reduced significantly both the amounts of COPs and TBARS values. The mechanism of the decrease of the concentrations of preformed oxidation products due to the addition of antioxidants is not clear yet and will be investigated. We think that the reduction/destruction of the intermediate peroxides might be involved in these processes.

Conclusions

The pasteurizing dosis of gamma radiation extended the microbiological safety and stability of mechanically deboned non-frozen turkey meat, however, it enhanced under aerobic packaging condition the concentrations of COPs and TBARS. The formation of COPs as well as lipid oxidation products could be inhibited significantly by the antioxidants tested.

Pertinent literature

Chizzolini, R., Novelli, E., Zanardi, E. (1998) Oxidation in traditional Mediterranean meat products. *Meat Science*, **49**: Suppl. 1, S87-S99.
Farkas, J. (1998) Irradiation as a method for decontaminating food. A review. *Int. J. Food Microbiol.*, **44**: 189-204.

- Hwang, K. T., Maerker, G. (1993) Quantitation of cholesterol oxidation products in unirradiated and irradiated meats. *JAOCs*, Vol.70, no.4:371-375.
- Lambert, J. D., Maxcy, R. B. (1984) Effect of gamma radiation on *Campylobacter jejuni*. *J. Food Sci.*, **49**: 665-667, 674.
- Lebovics, V.K., Antal, M., Gaál, Ö. (1996) Enzymatic determination of cholesterol oxides. *J. Food Sci.*, **71**: 22-26.
- Mermelstein, N.H. (2000) E-beam-irradiated beef reaches the market, papaya and gamma irradiated beef to follow. *Food Technol.*, **54** (7): 88-92.
- Ramanathan, L., Das, N.P. (1992) Studies on the control of lipid oxidation in ground fish by some polyphenolic natural products. *J. Agric. Food. Chem.* **40**:17-21.
- Sadat, T., Volle, C. (2000) Integration of a linear accelerator into a production line of mechanically deboned separated poultry meat. *Rad. Phys. Chem.*, **57**: 613-617.
- Thayer, D. W., Boyd, G., Fox, Jr., J.B., Lakritz, L., Hampson, J. W. (1995) Variations in radiation sensitivity of foodborne pathogens associated with the suspending meat. *J. Food Sci.*, **60**: 63-67.

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Table 1. Concentration of COPs (mg/kg) in unirradiated and gamma-irradiated mechanically deboned turkey meat (average from duplicated samples in two parallel experiments)

COPs	Day 0 (unirradiated)			Day 0 (3 kGy)			Day 15 (3 kGy)		
	C	AO	T	C	AO	T	C	AO	T
7 α -OH	2.04	1.11	0.89	3.06	1.40	1.34	3.63	1.73	1.78
7 β -OH	2.12	1.04	0.79	2.02	1.58	0.92	2.14	1.64	2.54
7-keto	2.50	nd	nd	2.70	nd	nd	2.39	1.67	0.97
5 α ,6 α epoxide	2.30	nd	nd	2.28	nd	nd	2.37	nd	nd
Total	8.96	2.15	1.68	10.06	2.98	2.26	10.53	5.04	5.29

Cholesterol content: 668,6 mg/kg

7 α -OH: 7 α -hydroxycholesterol; 7 β -OH: 7 β -hydroxycholesterol; 7-keto: 7-ketocholesterol; 5 α ,6 α epoxide: cholesterol-5 α ,6 α epoxide

C: antioxidant-free control; AO: α -tocopherol+ascorbic acid; T: thyme oil.

nd < 0,30 mg/kg

Table 2. TBARs (MAD mg/kg) in unirradiated and gamma irradiated mechanically deboned turkey meat

C	Day 0 (unirradiated)		C	Day 0 (3 kGy)		C	Day 15 (3 kGy)	
	AO	T		AO	T		AO	T
4.42	1.64	1.35	7.43	2.31	1.61	5.35	2.47	2.06

Abbreviations see as in Table 1.