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The desirability of approving the use of vacuum and modified atmosphere packaging because of its enhancement of product quality was supported by the research of Lambert *et al.*, (1992) and Grandison and Jennings, (1993).

### Effectiveness Of The Additive

The petition notes that a minimum dose of 0.3 kGy may be necessary to inactivate *T. spiralis* in hog carcasses, but a higher dose may be needed to eliminate the numerically and economically much more serious parasite problem caused by *Toxoplasma gondii*. Dubey and Thayer (1994) discovered that a pool of 105 *T. gondii* strains were rendered nonviable by a dose of 0.4 kGy. The petition states that a dose of 1 kGy apparently can control meat-borne parasites.

The petition notes that there is now good agreement that *E. coli* O157:H7 has a  $D_{10}$  dose in comminuted beef and chicken meat of about 0.25 kGy at 3-5°C and 0.3-0.45 kGy at -5 to -15°C (Thayer and Boyd, 1993; Clavero *et al.*, 1994). The greater radiation resistance of the Salmonellae, depending on the strain and irradiation conditions of less than 0.5 to around 1 kGy in chilled ground meat, is discussed (Thayer *et al.*, 1990; Clavero *et al.*, 1994). *L. monocytogenes* is reported to be about as radiation resistant as the Salmonellae, and the frozen state has a marked protective effect (El-Shenawy *et al.*, 1989; Grant and Patterson, 1992; Huhtanen *et al.*, 1989; Monk *et al.*, 1994, Thayer and Boyd, 1995). Radiation injury extended the lag phase of *L. monocytogenes* and the sensitivity of Salmonellae to heat (Grant and Patterson, 1995; Thayer *et al.*, 1991). Grant *et al.*, (1993) and Thayer and Boyd (1994) reported significant reductions of the number of vegetative cells of *Bacillus cereus* in both raw and cooked foods at doses of less than 3 kGy. El-Zawahry and Rowley (1979) and Tarkowski *et al.*, (1984) reported D-values for *Yersinia enterocolitica* ranging from 0.1 to 0.21 kGy in ground beef. The radiation resistance of *Staphylococcus aureus* in meat is reported to be in the range of 0.36 to 0.45 kGy (Monk *et al.*, 1994; Thayer and Boyd, 1992).

### Dosimetry And Detection Methods

The petition discusses why regulators must rely on proper record-keeping and dosimetry records inspection to assure compliance with regulations. Several post-treatment detection methods for the identification of irradiated foods, not for quantitative dosimetry, are reviewed in the petition, such as the EPR/ESR spectroscopic identification of stable free radicals in bone, and gas and high performance liquid chromatographic analysis of radiolytic products.

### Microbiological/Toxicological Safety And Nutritional Adequacy

One of the key questions of the safety of irradiated pre-packaged meats is a concern that *Clostridium botulinum* spores, if present, might under abuse conditions produce significant neurotoxin before the competing spoilage flora could produce obvious signs of spoilage. Dr. Giddings presented data that indicates that contamination with *C. botulinum* is

actually very rare. He also discussed a number of studies that tested this concept and indicated that it was an unlikely event (Firstenberg-Eden *et al.*, 1982, 1983; Maxcy, 1983; Thayer *et al.*, 1995). Other studies are cited that indicate that Salmonellae are unlikely to out compete the residual microflora on irradiated meat (Szczawinska *et al.*, 1991).

The studies of Fox *et al.* (1989a, 1989b, 1993, 1995) are cited in the petition to illustrate that the nutritional changes are minimal. The toxicological studies of Radomyski *et al.* (1965) and that of van Logten *et al.* (1983) are cited and discussed as part of the evidence that irradiated beef and pork are wholesome.

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