Preservation of Fish by Irradiation
(Proceedings of a Joint FAO/IAEA Panel, Vienna, 1969)

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Reviewer M. A. Robkin

Preservation of Fish by Irradiation is the report of the proceedings of a panel held in Vienna, December 15-19, 1969. For someone with even a general knowledge of radiation and biology, it is a very good survey of what one might expect to accomplish with radiation pasturization of seafoods. There are ten papers presented, and they overlap sufficiently to provide a unified collection, with enough variation of methods and species to make each paper relatively distinct.

Paper 1 by Ronsivalli et al., describes an interesting experiment in long distance shipping but does not discuss the results sufficiently. In particular, it would have been illuminating to discuss why the shipments to Jacksonville, Florida resulted in a lower plate count of the final bacterial titer (Table I) than did the shipments to Seattle, Washington. Presumably, the shorter distance is more important a factor than the effect on the packing ice of the higher average ambient temperature, but it would have been nice to have the authors discuss the difference. The authors do not identify the components of the bacterial titer, although it has been shown that the sensory evaluation of seafood depends strongly on which microorganisms are suppressed and which are growing. They also make a big point of the evaluation of the botulism hazard, but never actually present any real data. It would have also been interesting to learn why the organoleptic scores of the 200-krad samples never were superior to the scores from the 100-krad samples, even after a storage time longer than what might be expected for the disappearance of the fugitive irradiation odor. Since dosimetry is not discussed, the reader is left in the dark as to how reliable the irradiation dose can be considered.

Paper 2 by Laycock and Regier is a generally excellent review of the growth of aerobic organisms on irradiated fish, although again the authors do not discuss their dosimetry.

Paper 3 by dela Sierra Serrano reports on a very complete study under many varying conditions of storage of irradiated fish. He, also, does not report on the dosimetry and does not explain the entry "eliminated" in his tables. The author claims that irradiation of 100 krad resulted in no appreciable variation in the organoleptic source which is in distinct disagreement with most of the other authors (for example, paper 2, Fig. 1). This point certainly should have been discussed.

Paper 4 by Hannesson and Dagbjartsson is generally very good. The discussion of the dosimetry is complete and convincing. It is unfortunate that there is not an internationally agreed upon hedonic scale for the organoleptic evaluation of radiation processed seafoods. These authors use a five point scale, the basis of which is not disclosed, while most others use a five or ten point scale, the characteristics of which are told to the reader.

Paper 5 by Ehlermann and Munzer discusses the results of irradiating some fresh water species which makes a welcome addition to the remainder of the papers which all deal with seafoods. Their results with carp point up a fact known to fishermen: the coarser the fish the more abuse it will tolerate. They report a 30 to 1 ratio of the dose which can be applied to carp as compared to trout before a radiation induced loss of sensory quality is noticed.

Paper 6 by Kumta and Sreenivasan discusses some Asian species. Their paper is a long and comprehensive report on the chemistry and bacteriology of irradiated seafoods processed in a large variety of ways. There are only two points where they might be faulted. The first is the use of a storage temperature of 10 to 12°C for so much of their work. This seems like an unrealistically high temperature for serious preservation of fish and must have an effect on the distribution of the spoilage organisms as a function of storage time. The second is the evaluation of fish for freshness indices at 10°C. Certainly the detection of odors at a given state of spoilage will be considerably reduced by low temperature, and it seems to this reviewer that 20°C would be a fairer temperature to evaluate the organoleptic score in particular. Dosimetry is also not discussed.

Paper 7 by Matutano Aranda and Alonso Rodriguez discusses irradiation treatment of fillets of hake. They also use a five point hedonic scale but completely define it so that it is not too difficult to relate to a ten point scale. Their paper, however, suffers from some procedural and reporting defects. In particular, the sensory evaluation of the irradiated samples would be more convincing if they were mixed with the unirradiated samples in a blind test. Since the test panel knew that the fish were irradiated, one cannot help but suspect that the test scores were affected. (Appendix 3, paper 7). The cooking procedure was not the same for the irradiated and unirradiated fish, and without proof to the contrary one must assume that the relative subjective scores will be affected. There is no explanation of why the sensory scores of fish irradiated at 200 krad are higher at one week's storage than are the fish irradiated at 150 krad and lower after two weeks. One might suppose that if irradiation produces a fugitive "foreign odor" that it would be stronger for the higher dose level and that the higher dose would suppress microorganisms more strongly. Table IV is labeled to imply a dependence on packaging temperature, but no temperature data are given. Dosimetry is not discussed.

Paper 8 by Shewan and Hobbs is a very good exposition of the botulism hazard. The authors point out that *Clostridium botulinum* can grow, even at low temperatures, during an extended storage life. Although normal cooking destroys the toxin, the fanciers of raw smoked fish are advised to watch their step. Dosimetry again is not mentioned.

Paper 9 by Eklund and Poysky continues the story of the botulism hazard in rather greater detail. Their results show that the degree of risk depends not only on the storage temperature but on the species of fish. They raise the fascinating idea of the use of bacteriophages to control the growth of *Clostridium* and, like the Saturday matinee serial, leave the reader impatiently waiting

for the next installment. One hardly notices that once again dosimetry is an act of faith.

Paper 10 by Leone finally gets down to cases and considers the pitfalls of dosimetry which can trap the unwary. He shows that for a fairly standard irradiation geometry, the exposure can be nonuniform by as much as a factor of 2. Since very different results in fish quality and biological load are seen within dosage variations smaller than a factor of 2, his warning seems very timely.

The summary statement at the end of the book is, in the opinion of this reviewer, excellent. It would, if one were tempted to plagiarize, serve as an admirable review in its own right.

The number of misprints, missteps, and mistakes are minimal and, for the price ($5.00), packs a lot of information in its 160 pages. If you have irradiated fish to fry, its a good book to have.

Maurice Robkin received his PhD at Massachusetts Institute of Technology in nuclear engineering. Since 1967, after a six-year stint at the Vallecitos Atomic Laboratory with the plutonium recycle program, he has been an associate professor in the Department of Nuclear Engineering at the University of Washington. His primary interest and research efforts at the U of W have been in bio-nuclear engineering. He is a member of, among others, the American Nuclear Society, the Radiation Research Society, and the Northwest Steelheaders Council of Trout Unlimited (which may explain his interest in fish).