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A Comparative Study on the Radiation Preservation of Marine (Seer fish) as well as Fresh Water Fish (Cat fish)

P.S. Sreerekha*, K.M. Nishamol*, M.D. Alur and D.R. Bongirwar
Food Technology Division
Bhabha Atomic Research Centre
Trombay, Mumbai - 400 085, India

Seer, a marine fish and cat fish, a fresh water fish, were compared for their amenability to radiation preservation during storage at 2-3°C employing sensory, bacteriological and biochemical parameters. Although both the fish varieties exhibited a two-fold extension in shelf life by radiation treatment at 1-3 kGy over controls, the biochemical parameters tested (TMAN and TVBN) failed to monitor the quality of fresh water fish (cat fish). On the other hand, with respect to marine fish (seer), biochemical and microbiological quality correlated well with sensory evaluation data.

Key words: Cat fish, seer fish, radiation preservation, TMA, TVBN, microbiological quality

Although world fish production is steadily increasing, preservation of the commodity still remains a challenging problem. Susceptibility of fish to rapid spoilage has been attributed to its intrinsic characteristics and to possibilities of microbial contamination from a variety of sources (Venugopal, 1990; Ward & Baj, 1988). Conventional chilling and refrigeration have limited effects of psychrotrophs and several pathogenic microorganisms harbouring the fish (Palumbo, 1986).

Treatment of foods by ionizing radiation (gamma rays, electrons or X-rays) has recently emerged as a promising method for control of contaminant microorganism in foods, particularly after the declaration of Joint Expert Committee on Food Irradiation (JECFI, 1981) that irradiation of any food commodity up to an overall average dose of 10 kGy presented no toxicological hazard. The process reduces both post-harvest food losses and public health hazards arising from pathogens (Chinsman, 1987). An average dose of 3 kGy can extend the storage life of chilled fish 2 to 3 fold (Giddings, 1984; Nickerson *et al*, 1983). The objective of the present investigation was to compare the effects of gamma irradiation on the biochemical and microbiological parameters in a marine fish as well as a fresh water fish stored at 2-3°C.

Materials and Methods

Fresh seer fish (*Scomberomorus commerson*) and cat fish (*Clarias batracus*) were purchased from local fish market at Chembur, Mumbai. The fish after washing thoroughly in potable water, was processed. The processing consisted of evisceration of the fish, washing under running tap water, sealing in polythene (500 gauge) pouches, icing the bags in aluminium boxes and exposure to average doses of 1, 2 and 3 kGy (^{60}Co, Pencil source, 75,000 curie, Food Package Irradiator).

Irradiated seer fish and cat fish samples were analyzed at regular intervals for organoleptic score (OS). The scoring was done on a reference scale, based upon the odour and appearance of fish which was

* Present address: M.E.S. Ponnani College, Ponnani, Kerala State, India

adopted from Miyauchi *et al.* (1964). The score of 5 was taken as limiting score of acceptability of representative fish samples. Total bacterial count (TBC), total volatile base nitrogen (TVBN) and trimethylamine nitrogen (TMAN) were determined at regular intervals.

For determination of total volatile base nitrogen (TVBN) and trimethylamine nitrogen (TMAN), 10 ml of 10% fish homogenate in water was treated with an equal volume of 10% trichloroacetic acid (TCA) and the slurry was filtered through Whatman No.1 filter paper, after 15 min contact time. TCA filtrate (1.0 ml) was used to determine TVBN by Conway microdiffusion technique (Farber & Ferro, 1956). TMA was also determined from TCA filtrate by the method of Dyer (1945). A 10g sample from the fish fillet was aseptically homogenized for 1 min with 90 ml of sterile saline using Sorvall Omnimixer. Appropriate dilutions of homogenates were placed in petri dishes in duplicate. The colony forming units (cfu) were determined using plate count agar (Difco, Detroit, USA). Plates were incubated at 26°C for 48 h (APHA, 1976).

Results and Discussion

Figures 1 and 2 depict the total plate count of non irradiated and irradiated seer fish and cat fish respectively during storage at 2-3°C. It may be noted that initial bacterial load of both non-irradiated seer and cat fish was 10^6. g^{-1} However, after irradiation at 1-3 kGy, TPC value was

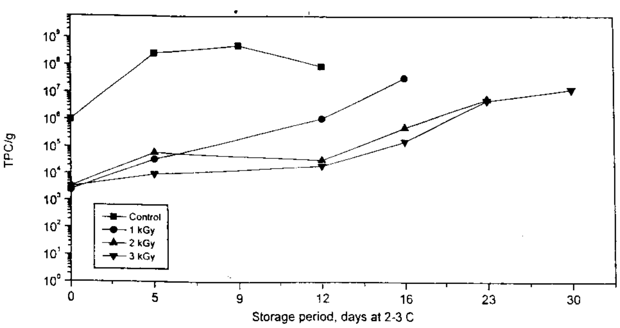

Fig. 1. Total bacterial counts of unirradiated and irradiated seer fish during storage.

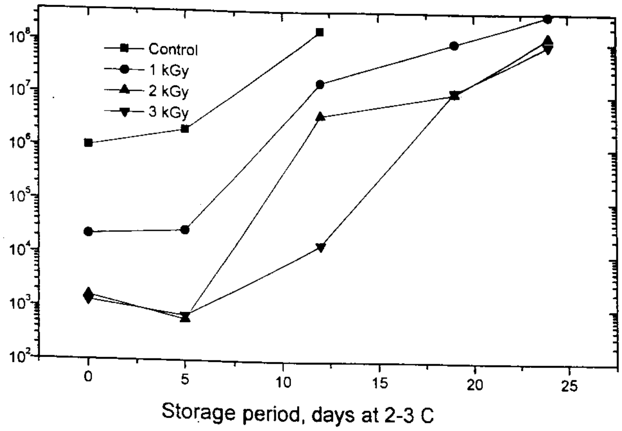

Fig. 2. Total bacterial counts of unirradiated and irradiated cat fish during storage.

brought down by 2-3 log cycles in both samples. During storage, TPC increased to the level of > 10^8. g^{-1} after 9 days and 12 days, respectively in non-irradiated seer and cat fish. On the other hand, in irradiated fish, growth of bacteria was slow reaching a value above 10^7. g^{-1} after 12-15 days in samples exposed to 1 kGy of gamma radiation. However, samples exposed to 2-3 kGy exhibited TPC values of 10^7. g^{-1} after 18-20 days.

Both irradiated seer fish and cat fish held in ice remained in acceptable condition up to 18-20 days as against 9 days for non-irradiated counterparts under the same condition.

Sensory evaluation data on non-irradiated and irradiated seer and cat fish are given in Fig. 3 & 4, respectively. Sensory score dropped rapidly in non-irradiated

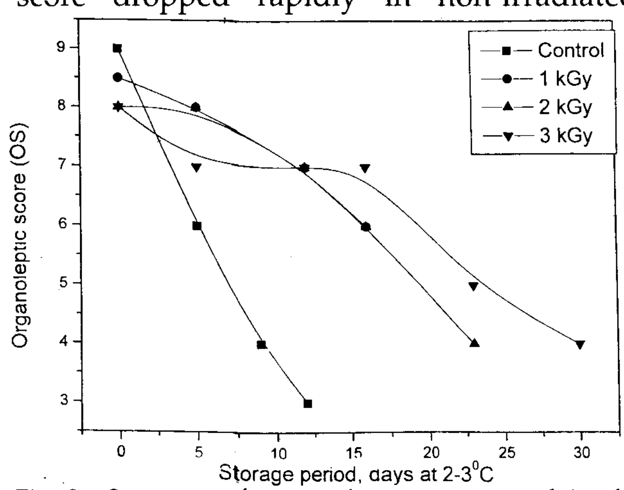

Fig. 3. Sensory evaluation of unirradiated and irradiated seer fish during storage.

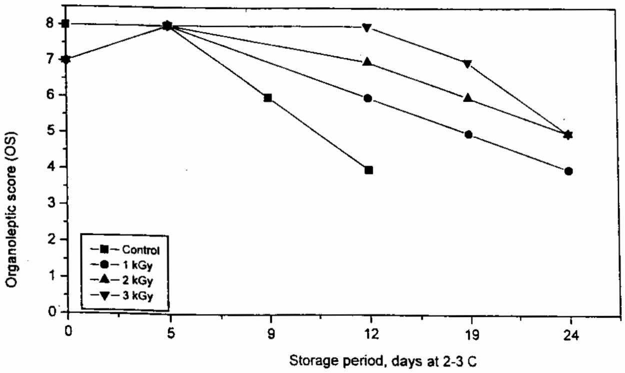

Fig. 4. Sensory evaluation of unirradiated and irradiated cat fish during storage.

samples reaching a value of 5 after 7 and 10 days in seer and catfish respectively. In contrast, sensory scores declined at a slower rate in irradiated samples. Thus, sensory score of 7 was maintained for 15-16 days in the case of irradiated (1-3 kGy) seer fish while in cat fish (2-3 kGy) the score remained at this level for 12 days.

Biochemical evaluation of non-irradiated and irradiated seer and cat fish revealed that formation of TMAN was rapid, reaching a value of 1.7 mg% after 5 days at 2-3°C in non-irradiated seer fish which registered further rapid increase to an unacceptable level of 3.0 mg% after 12 days (Fig.5) whereas, fresh water cat fish, never registered TMAN values above 0.8 mg% during the entire period of storage, indicating that TMAN does not serve as an index of freshness for fresh water cat fish (Fig.6). TMAN values were consistently low in irradiated seer fish (>1.0 mg%).

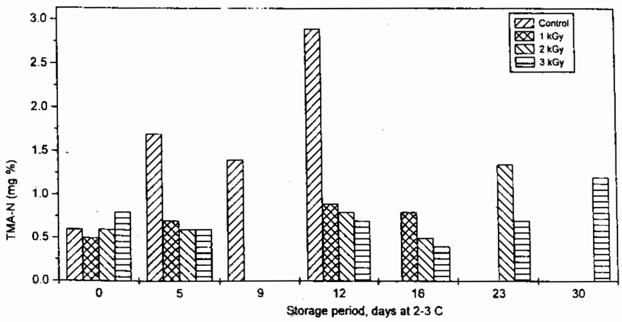

Fig. 5. TMAN in unirradiated and irradiated seer fish during storage.

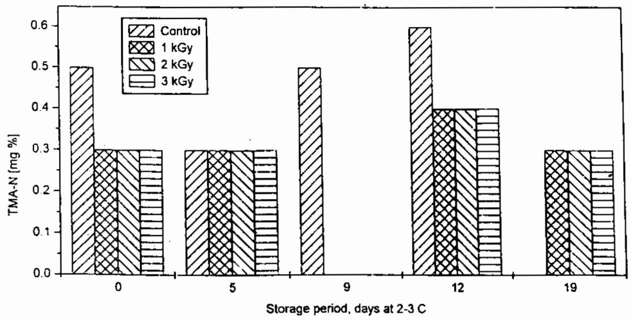

Fig. 6. TMAN in unirradiated and irradiated cat fish during storage.

TVBN levels increased to 60-70 mg% after 9 days of storage of seer fish at 2-3°C and further to an unacceptable level of 170 mg% after 12 days of storage (Fig. 7). It was of interest to observe that TVBN values in non-irradiated fresh water cat fish never reached beyond 60 mg% (Fig. 8) though sensory as well as bacterial analysis indicated spoilage of samples. Thus, TVBN also appears to fail to detect spoilage of fresh water fish. Irradiated samples of both seer and cat fish always registered lower levels of TVBN in comparison to the respective controls.

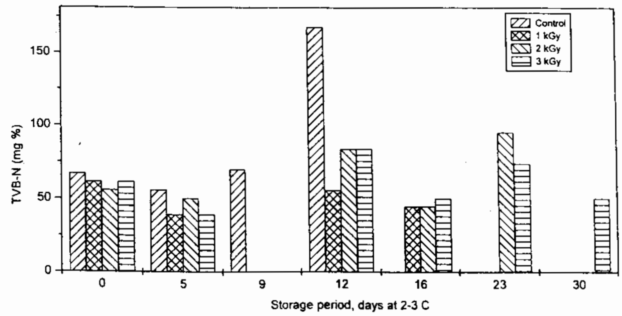

Fig. 7. TVBN in unirradiated and irradiated seer fish during storage.

Food irradiations being a new process, has to satisfy many criteria from the regulatory point of view before its large scale application. Evaluation of wholesomeness is essential to convince health officials and the consumers the nutritional, microbiological and toxicological safety of the processed food. Rigorous feeding trials in which several foods were fed to mammals have failed to show any adverse effects of consumption of these foods. These studies

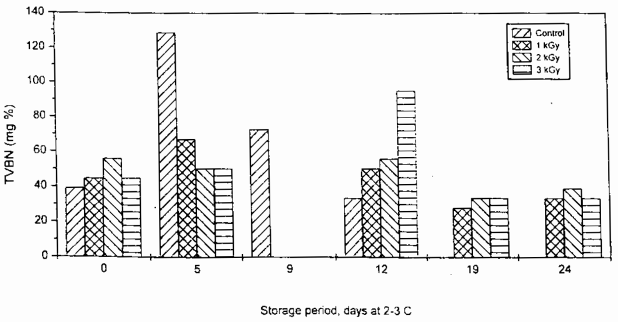

Fig. 8. TVBN in unirradiated and irradiated cat fish during storage.

led to FAO/IAEA/WHO Joint Expert Committee to conclude that foods treated to an overall average dose of 10 KGy presented no toxicological hazard (JECFI, 1981).

Detection of irradiated food is essential for proper process control as well as identification of the processed items during marketing. Low dose irradiation does not cause significant changes in fresh fishery products. Development of simple and rapid methods for identification of irradiated fish has not been successful. Some of the methods developed recently for this purpose are based on electron spin resonance, radiolytic products etc. (Bradford, 1989). Gore *et al* (1982) showed that irradiation resulted in enhanced release of lysosomal enzymes in the press juice of irradiated Bombay duck, pomfret and *Tilapia*, which could be measured to identify the treated fishery items. Alur *et al.* (1991) suggested that microbial spoilage profiles could be used to identify irradiated fishery products. It was observed that certain microorganisms responsible for spoilage of fish produced significantly less volatile bases and acids when allowed to grow in fish irradiated at doses of 1 to 5 kGy.

The present investigation also corroborates earlier findings that marine fish, seer, exposed to gamma radiation doses of 1-3 kGy, consistently produced half the amount of TMAN and TVBN in comparison to controls. However, these methods fail to detect irradiation of fresh waterfish (cat fish) since both TMAN and TVBN were produced in small amounts and further there was no significant difference in their levels between non-irradiated and irradiated cat fish.

In India, radiation processing has been cleared for the treatment of frozen seafoods for elimination of pathogens. It is anticipated that multi-purpose irradiation plants with attached refrigeration facilities could be used for the purpose of shelf-life extension of fish. Installation of such irradiators at the landing centers would help treatment of fresh fish so as to provide economically viable operation of the plant. It should be emphasized that adherence to high initial quality of the raw material and good manufacturing practices including stringent temperature control are necessary to make preservation of marine as well as freshwater fish by irradiation feasible.

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