

Irradiation and Potassium Sorbate Compared as Preservation Treatments for Atlantic Cod, *Gadus morhua*

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Introduction

The use of ionizing radiation as an effective method for extending the refrigerated shelf life of fresh fish has been known for many years (Nickerson et al., 1954), and the subject has been covered in depth in a more recent review (Nickerson et al., 1983). However, the process is not yet being used commercially in this country for seafood applications pending approval by the U.S. Food and Drug Administration (FDA).

Various chemicals and preservatives, such as the nitrites, benzoates, and others, have been tested for their efficiency in preserving fresh fish (Tomisayu and Zenitani, 1957), but we are not aware of any being used commercially in this country. Probably the most effective of these preservatives tested, the tetracyclines (Torry Research Station, 1971), were disallowed by the FDA. A more recent generation preservative, sorbic acid or potassium sorbate, has been reported effective in extending the shelf life of fresh whole broilers (Robach, 1979), and it has also been found to be effective with certain seafoods (Debevere and Voets, 1972; Chung and Lee, 1981; Bremner and Statham, 1983; Shaw et al., 1983; and Ampola and Keller, 1985). This compound is on the GRAS (generally recognized as safe) list. Therefore, a comparison of the efficiency of these two seafood preservation methods (irradiation vs. sorbate

treatment) may be useful for those fish processors who may not have access to an irradiation source or service, when the process is sanctioned for use.

Experimental Methods

Eviscerated, market-size Atlantic cod, *Gadus morhua*, of 1 day post mortem age were obtained from a Gloucester, Mass., "day boat." Two fillets were removed from each fish: One fillet was packaged in a Curlon S-660¹ (nylon-PVDC-surlin) pouch and irradiated in the Marine Products Development irradiator (Cobalt 60) at the Gloucester Laboratory of the NMFS Northeast Fisheries Center to a maximum absorbed dose of 100 Krad (1 kGy) and the other fillet was dipped for 40 seconds in a 5 percent potassium sorbate solution, drained, and then packaged in a sealed pouch. Fillets to serve as control samples were taken from random fish of the same catch. Following the various treatments, the packaged samples were stored in flake ice in a walk-in refrigerator (2-5°C).

Sensory Analysis

Each fillet, after first removing a 50 g sample for bacterial analysis, was evaluated in the raw state for odor and in the cooked state for flavor and texture by a six-member panel comprised of the laboratory staff experienced in judging cod. Samples were scored on a scale ranging from 9 = excellent to 1 = inedible, and were considered unacceptable when the average score for an

attribute fell below 5.5. For sensory evaluation of the cooked product, the fillets were placed in a foil-covered pan and steamed (100°C) for 12-15 minutes. Each panelist was served an approximate 50 g portion.

Aerobic Plate Count

The aerobic plate count (APC) was made from appropriate sample dilutions onto pour plates of TPE agar (standard methods agar) reinforced with 0.5 percent Bacto peptone and 0.5 percent sodium chloride as recommended by Lee and Pfeifer (1974) for seafoods. Duplicate plates were incubated at 20°C and colony counts were made after 5 days.

DMA and TMA

Dimethylamine (DMA) and trimethylamine (TMA) analyses were performed by a gas chromatographic method (Lundstrom and Racicot, 1983). Results were reported as mg amine nitrogen/100 g.

Hypoxanthine

The enzymatic procedure described by Jones et al. (1964) was employed for determination of hypoxanthine content.

pH

A 20 g composite sample of muscle from various sections of the fillet was blended with 40 ml distilled water for 1 minute, and the pH of the slurry was measured with a Fisher Model 320 expanded scale pH meter. Skin surface pH

ABSTRACT—Treatments of fresh Atlantic cod, Gadus morhua, fillets with either 100 Krad gamma irradiation or a sorbate dip were found to be comparably effective in extending the iced storage life.

¹Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

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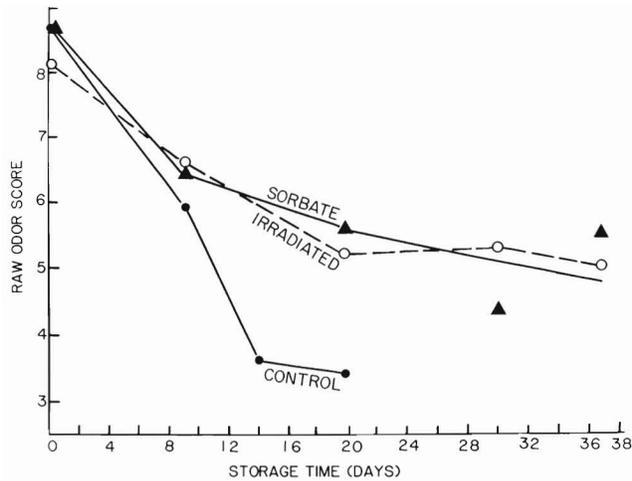


Figure 1.—Odor score during iced storage of Atlantic cod fillets.

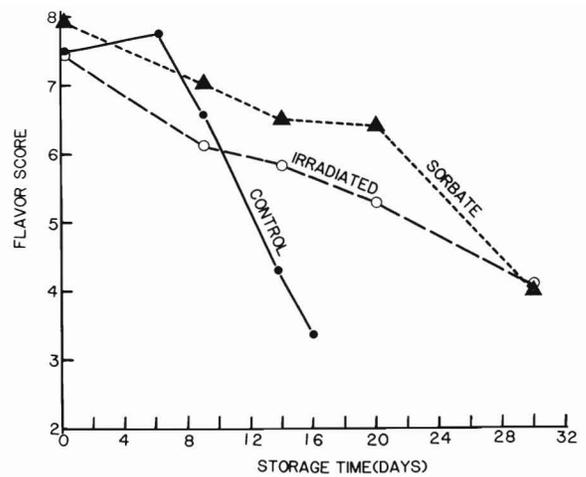


Figure 2.—Flavor score during iced storage of cod fillets.

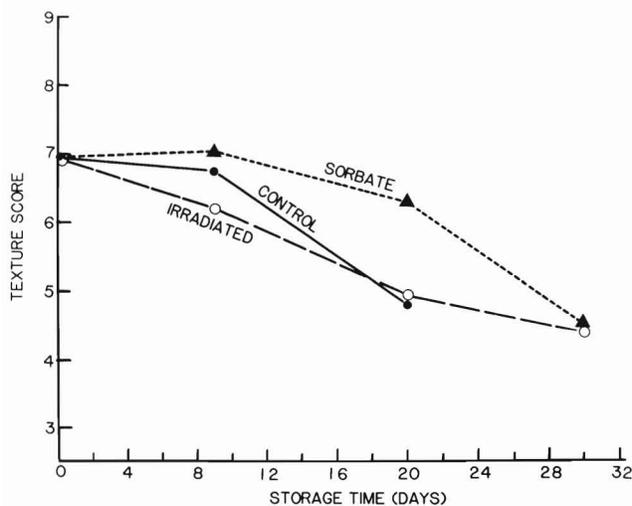


Figure 3.—Texture score during iced storage of cod fillets.

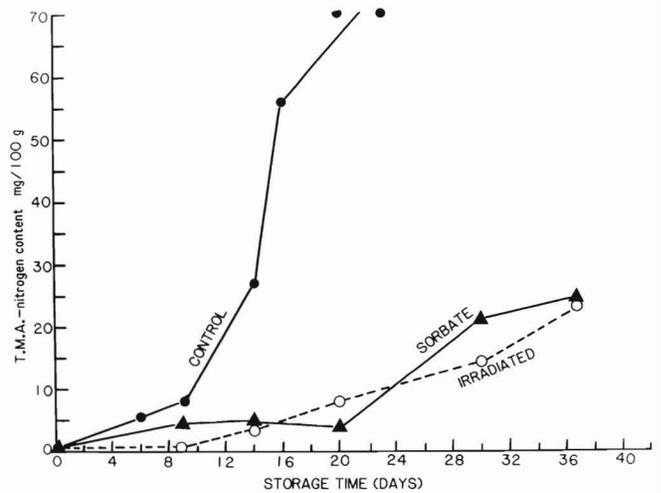


Figure 4.—Trimethylamine nitrogen content during iced storage of cod fillets.

was also monitored using an epoxy-body flat-surface combination electrode (No. 1208, Markson Science Inc.) in conjunction with a Fisher Accumet Model 230 pH meter. For equilibration, the electrode was submerged in ice water for 10-15 minutes prior to standardization with a pH 7 buffer at 1°C and, after use, rinsed with chilled distilled water.

Results and Discussion

The decline in odor score of the raw, variously-treated fillets during iced storage can be seen in Figure 1. Both

the sorbate and irradiation treatments helped to preserve fresh odor and both treatments seemed comparable in this effect. The flavor score of the control samples also decreased at a faster rate during storage compared with the treated samples (Fig. 2). At any given test period, the sorbated fillets scored slightly higher in flavor compared with the irradiated samples, but this could have been due to a slight "irradiation" flavor in the irradiated samples and not to decomposition. Nevertheless, based on raw odor and cooked flavor scores,

the controls were considered of marginal quality after 11 days, whereas the treated samples did not reach this stage until about 18-22 days. Texture deterioration during storage was considered comparable among all three treatments (Fig. 3).

Both the sorbate and irradiation treatments were effective in retarding trimethylamine formation in the fillets and both treatments were comparable in their effect (Fig. 4). From the graph, it is estimated that the TMA nitrogen content of the control at marginal quality

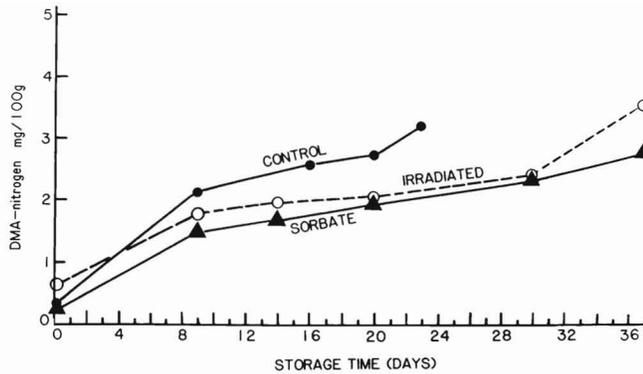


Figure 5.—Dimethylamine nitrogen content during iced storage of cod fillets.

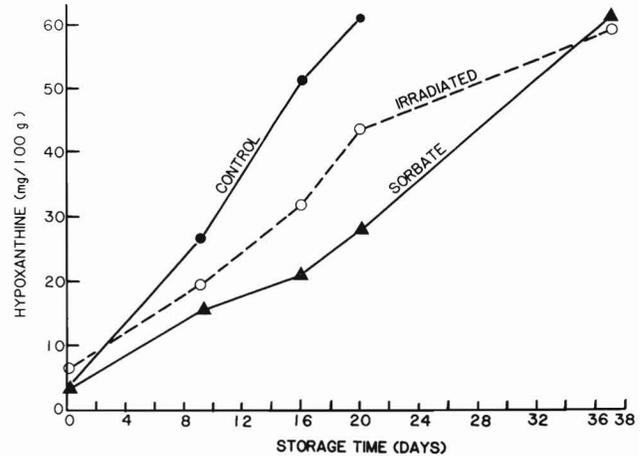


Figure 6.—Hypoxanthine content during iced storage of cod fillets.

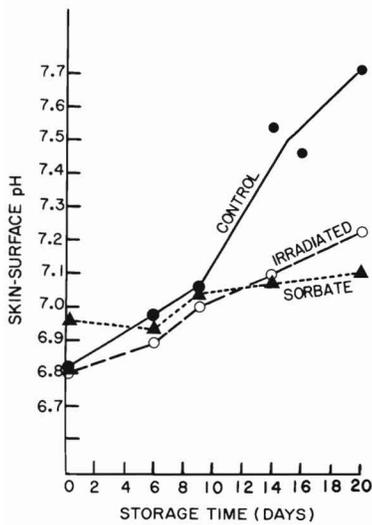


Figure 7.—Skin-surface pH during iced storage of cod fillets.

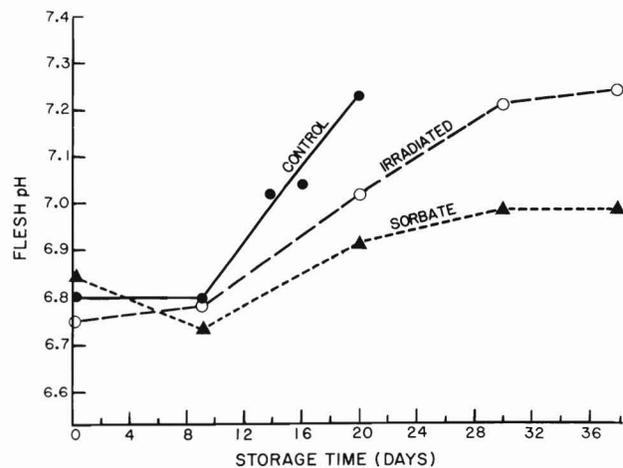


Figure 8.—Flesh pH during iced storage of cod fillets.

(11 days) was 15 mg/100 g. This value is in agreement with the value suggested by Dyer and Dyer (1949) for cod fillets.

The production of dimethylamine, another amine formed by bacterial action on fish (Dyer and Mounsey, 1945), was also less in the treated fillets compared to the control (Fig. 5) and there was no difference in rate of DMA formation between the irradiated and sorbate treatments.

Hypoxanthine, a product of post-mortem nucleotide degradation, increased steadily during storage among all treat-

ments but at a faster rate in the control samples (Fig. 6). The rate of increase was about the same for the irradiated and sorbated samples. Hypoxanthine formation in fish during the early post-mortem period is thought to be due mainly to autolytic enzyme activity, and in the later storage periods bacterial activity plays a major role (Jones, 1965; Burt, 1976).

The change in pH during storage as measured both on the skin surface and a muscle homogenate can be seen in Figures 7 and 8, respectively. In general,

there was much variability among individual fillets, but the results did show that after a delay of several days, the control sample increased more rapidly in pH compared with the two treatments, most probably due to microbial action and the production of amines. For the three different treatments, skin surface pH correlated well with flesh pH. Correlation coefficients ranged from 0.82 to 0.90. However, from linear regression analysis, we found that skin surface pH readings were about 0.1-0.2 pH units higher than flesh readings.

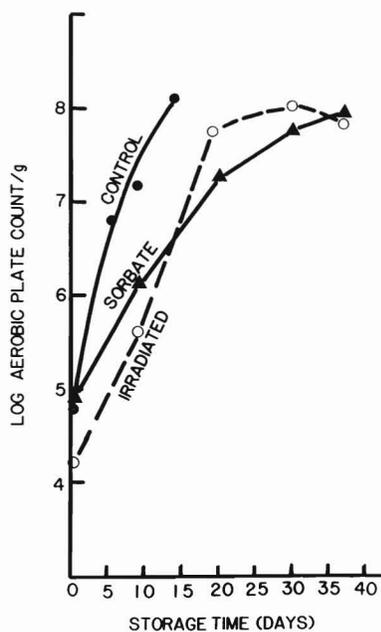


Figure 9.—Aerobic plate count during iced storage of cod fillets.

This was not attributed to the meter since the instrument was standardized at the beginning of the tests. Since aerobic bacterial growth is enhanced on air surfaces, there probably was a slightly greater concentration of alkaline metabolites on the skin. Nevertheless, surface pH measurement might be a simple, rapid method for assessing quality of fresh whole fish.

Total aerobic plate counts are presented in Figure 9. The counts increased most rapidly in the control samples, and at about the same rate in the irradiated and sorbated samples. The total plate

count for the controls at time of marginal quality was estimated as 4 million per gram, whereas for treated samples the estimate was 10 million per gram. The higher spoilage count for the treated samples may have been indicative of a shift in flora to a less metabolically active type.

Conclusions

The two treatments studied (100 Krad ionizing irradiation, and a 5 percent potassium sorbate dip) were comparably effective in extending the iced storage life of fresh Atlantic cod fillets. However, the irradiation treatment does have certain advantages over the sorbate treatment. It avoids the use of a dip solution which has to be kept clean to avoid bacterial build up, has to be replenished to maintain constant concentration, and which requires a drain period prior to packaging. In addition, the irradiation process will inactivate certain pathogenic bacterial contaminants in addition to the spoilage types. However, for those without access to an irradiation facility or service, sorbate treatment could be useful for extending fresh shelf life of fish fillets.

Acknowledgment

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