Shelf Life Extension of Drawn Whole Atlantic Cod, *Gadus morhua*, and Cod Fillets by Treatment With Potassium Sorbate

VINCENT G. AMPOLA and CYNTHIA L. KELLER

Introduction

Despite attempts to improve handling practices and sanitation, seafoods remain one of our most perishable foodstuffs. The primary limiting factors in the shelf-life of seafoods is the unavoidable contamination by spoilage bacteria during processing, and by their proliferation during storage. The method studied in this work seeks to preserve fish and extend its shelf life by the use of a safe chemical preservative, in this case potassium sorbate (KS) which has been shown to inhibit those bacteria responsible for spoilage odors.

Vincent G. Ampola is a Research Food Technologist at the Gloucester Laboratory, Northeast Fisheries Center, National Marine Fisheries Service, NOAA, 30 Emerson Avenue, Gloucester, MA 01930. Cynthia L. Keller, now retired, was a Senior Research Microbiologist at the Nutrition Chemicals Division, Monsanto Agricultural Products, St. Louis, Mo.

**ABSTRACT**—Potassium sorbate has been used as an antifungal and antimicrobial agent in foods for many years, and has been generally recognized as safe (GRAS) by the U.S. Food and Drug Administration. Since its specific action on bacterial growth or inhibition has not yet been clearly established, especially in seafoods, an empirical experiment was conducted wherein fillets cut from Atlantic cod, *Gadus morhua*, of known post-capture age (i.e. 1, 3, and 5 days) were dipped in 2.5 and 5.0 percent fresh potassium sorbate, individually packaged in either polyethylene or polyethylene-ephalate pouches, iced, and given sensory examinations at 2- to 3-day intervals until the end of acceptable shelf life (when any sensory attribute average at either the raw or cooked evaluation fell below 5.0 (borderline) on a 9-point objective scale). We found that dipping fillets in 2.5 and 5.0 percent potassium sorbate and individually packaging them in plastic film, especially oxygen resistant polyethylene-naphthalate, was definitely beneficial in extending the iced shelf life of the fillets, in some cases more than doubling it. Dipping in potassium sorbate was effective in retarding trimethylamine formation. Shelf life was not appreciably extended for fillets cut 1, 3, and 5 days post-capture from whole, gutted cod that had been stored in chilled sea water containing 0.5 percent potassium sorbate for 2 days prior to filleting and sensory examination.

Materials and Methods

Dipping Fish Fillets in Potassium Sorbate

Commercially filleted and skinned Atlantic cod fillets cut from 1-, 3-, and 5-day-old iced fish were used. Each fillet was dipped about 15 seconds in cold, fresh 2.5 or 5.0 percent (w/w) KS solutions (<24 hours old), placed either in 0.75 mil low-density polyethylene or...
Cooked Fillets

The fillets were then cut into twelve 1.5x1.5-inch squares, placed in foil-covered pans in a double boiler, steamed for 12 minutes, and then served to the panel on coded plates. The samples were evaluated for appearance, odor, flavor, and texture using the same 9-point scale.

The acceptable shelf life of each sample was considered at an end when the average of any sensory attribute such as odor or flavor, either in the raw or cooked tests, fell below 5.0 (borderline). If, for example, an average for a sensory attribute scored below 5.0 on day 16 of storage, and it was acceptable on day 13, its shelf life would be 14-15 days and would be reported as 14.5 for statistical purposes. Each experiment on fillets cut from 1-, 3-, and 5-day-old cod, was repeated three times and the results were averaged.

TMA Analysis

Fillet samples dipped in 2.5 and 5.0 percent KS as well as nondipped controls were sent to the Monsanto Company Food Analysis Laboratories, St. Louis, Mo., for TMA and microbiological analysis. These samples were stored at 2°C. At 3- to 4-day intervals, duplicate samples from each treatment were frozen. At the conclusion of the refrigerated storage period, all frozen samples were analyzed in triplicate for trimethylamine content by gas chromatography. The chromatograph was equipped with a nitrogen-phosphorus selective detector and temperature programmer. The column was 1x2 mm i.d., glass packed with 80/100 Chromosorb 103. (Conditions: Helium, 30 ml/minute; air, 60 ml/minute; hydrogen, 3.5 ml/minute; injection port, 200°C at 16°C/minute; detector, 300°C).

A 10 g sample of fish flesh was homogenized in 20 ml of 6 percent HClO₄. The mixture was filtered and 2 ml of filtrate was mixed with 2 ml n-amyl alcohol and 2 ml of 65 percent KOH. This mixture was heated at 60°C for 10 minutes, shaken 5 minutes, then centrifuged at 1,500 rpm for 5 minutes. One microliter of the supernatant was injected into the gas chromatograph, and the area of the peak at the retention time of TMA was measured. Total aerobic bacterial plate counts were done on each sample taken for trimethylamine analysis.

Results and Discussion

KS Dipped Fillets

Sensory Analysis

Tables 1, 2, and 3 show the shelf life of cod fillets cut from 1-, 3-, and 5-day-old fish, dipped in 2.5 and 5.0 percent KS, and packaged in either 0.75 mil low-density polyethylene or 4.5 mi Scotchpak pouches. Shelf-life end points and their averages are given for each treatment.

The results indicate that dipping these fillets in KS solutions extended their refrigerated shelf life appreciably, in some cases more than doubling it. The fact that shelf life in some cases was much longer than that of fillets of the

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

same age in another experiment cannot be explained, but it may have been due to inadvertent receipt of fillets cut from fish of lower quality—possibly from fish from the bottom of the fish hold or from poorly iced fish. In several cases, low scores from one or two panelists terminated shelf life prematurely.

Shelf life extension of the dipped fillets, especially those individually packaged in Scotchpak, tended to be longer with increasing age of the fish from which they were cut. This may be due to the microbiological protection of the flesh from contamination by the unbroken skin during the 3-5 days of iced storage.

The most effective KS treatment for extending fillet shelf life was a dip in 5 percent KS with individual packaging in 4.5 mil Scotchpak and storage at 33-34°F. At no time did any panelist detect any odor or taste that could be attributable to potassium sorbate.

**TMA Analysis**

Table 4 shows the results of the TMA analyses for the control and KS-dipped fillets. Potassium sorbate was very effective in retarding TMA formation. This observation is consistent with the results of Debevere and Voets (1972) and their conclusion that sorbate is particularly inhibitory toward seafood "spoilers." Bacterial reduction was not evident in KS-dipped fillets. Counts for the controls and dipped fillets were about the same, although work by Kruk and Lee (1982) with *Escherichia coli*, showed that sorbate was inhibitory toward TMAO reductase activity. The reduction in TMA production is quite apparent in the sensory scores our panelists assigned to fillets treated with sorbate, since TMA is a principle early sensory indicator due to its characteristic spoiled fish odor. Nondipped control fillets were rejected due to strong TMA production. Dipped fillets were finally rejected due to other odors (musty).

**Drawn Fish Held in CSW With KS**

Table 5 shows the shelf life of whole drawn cod, 1, 3, and 5 days post-capture, held in 0.5 percent KS in CSW for an additional 2 days, then reiced in boxes and stored at 1°C. These fish, both raw and cooked, were compared with conventionally iced fish and with fish held in CSW (controls).

Storage of 1- and 3-day-old fish in 0.5 percent KS in CSW did extend their shelf life over the iced and CSW treated controls, but only slightly. This difference in shelf life does not appear to warrant storage of fish in CSW containing 0.5 percent KS. Possibly storage in...
CSW containing more than the percentage of KS used for this work would prove beneficial.

Conclusions

The use of a potassium sorbate dip for Atlantic cod fillets cut from iced fish up to 5 days old was definitely beneficial in extending the shelf life of the packaged fillets, especially those packaged in a relatively oxygen impermeable film like Scotchpak. In some cases, the shelf life of the dipped, iced fillets was more than double that of nondipped controls. Dipping fish fillets in both 2.5 and 5.0 percent potassium sorbate inhibited TMA formation, one of the principle and early indicators of fish spoilage. At no time did the panelists smell or taste the presence of potassium sorbate. This method, therefore, is recommended for commercial use. Holding 1- to 5-day-old fish in CSW containing 0.5 percent KS for 2 days was slightly useful in extending shelf life, but is not considered economically feasible.

Literature Cited


