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\* BENZOATES AS AIDS IN KIPPERED FISH PRESERVATION

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The process of kippering is one of mildly salting and moderately smoking fish. Amounts of both operations are variable depending upon producer and consumer likes and dislikes.

In kippering total preservation is not affected. Lightly kippered products are very subject to spoilage. The average kippered fish is apt to show evidences of spoilage in one to five or six days in warm weather. This fact is due to an insufficient amount of the preserving agents, namely salt and smoke. Since salt is used mainly for the purpose of seasoning, it is not used in quantities large enough to effect an inhibition of the development of micro-organisms. Smoke or smoke end-products tend to retard or inhibit the growth of micro-organisms, yet since the smoke end-products deposited on the fish in kippering are not sufficiently inhibitory to preserve the fish, it is desirable to discover some means of prolonging the storage life of this product.

Benzoates and related substances have been used for many years in aiding the preservation of various foodstuffs. Food products often show that sodium benzoate has been added--not in amounts large enough to impair flavor but sufficient to aid in the preservation of the product.

European, Canadian, and native fish products manufacturers have long used different substances as aids in the preservation of their products. Salt has been used for many years as the preserving agent or as an aid in the preservation of a number of products. Vinegar, which is largely acetic acid, salicylic acid and boric acid were used along the northeastern seaboard. More recently chlorine has been found satisfactory and is used by some producers.

Use of Benzoates in Preservation

Since benzoic acid and its salt, sodium benzoate, have been used successfully in the preservation of some foodstuffs, it was deemed advisable to study its effect in connection with fish preservation. Work done over a period of three years on both coasts showed that these substances could be used advantageously in the production and handling of fresh fillets. These studies proved that a combination of benzoic acid and sodium or magnesium benzoate when used with salt extended the storage life of fresh fillets held under normal conditions.

\* If this product is manufactured for sale, a statement indicating that Sodium Benzoate not in excess of 1/10 of 1% is present must be indicated on the label. Before selling a product of this type, clarification of this statement should be obtained from the Food and Drug Administration, Seattle, Washington.

When the problem of stopping mold development losses of kippered fish arose, it was at the time of the conclusion of the work upon fresh fillets. Since the combination of benzoic acid and sodium benzoate in the presence of ordinary salt had proved its worth in this instance, the combination was deemed possibly applicable to kippered fish production procedures. Thus this particular problem was considered and experiments were outlined. Through the cooperation of industries, fish and chemicals were obtained.

In the kippering procedure there are several instances in which the benzoate treatment could be made. These are:

1. In the brine
2. In the coloring solution
3. After smoking
  - a. before cooling
  - b. after cooling and before packaging

The brining solution seemed to be the most logical place for the benzoate treatment in the entire procedure as it would not require any unnecessary handling, and it would be comparable to the fresh fillet dipping procedure. Subjecting fish to the benzoates in this step of the process would allow for excellent absorption. The possibility of using the benzoate combination in the coloring solution was given consideration, but it was found that momentary dipping in the coloring solution was insufficient for adequate absorption of the bactericidal agents. Furthermore, the variability of the concentration of the benzoates in this solution was considered a problem. The possibility of dipping after the smoke treatment was apparent. It might be done as the fish came from the smoking chambers and was still hot or after the fish had been allowed to cool. The obvious disadvantages of such treatments were that they would require extra handling and that they would tend to impair the appearance of the kippered fish--a factor so important in its sale.

These various procedures were tried both in the laboratory and in commercial practice. The first method--that of adding the benzoates to the brine--proved itself to be most satisfactory. Absorption is good. Flavor and color are not impaired and inhibition of microorganisms is effected. The use of the benzoates in the other steps of the procedure is not satisfactory. When they were used in the coloring solution the momentary dip did not allow absorption of enough of the inhibitory or growth-preventing agents to be effective. The trials of dipping after the smoke treatment, either when hot or cold, had the distinct disadvantage of impairing the appearance. The smoked pieces after such treatment took on a watery white cast which destroyed the appetizing smoky brown.

Amounts of benzoates, brine concentrations, time, temperature, wrapping, storage, and handling were various factors given consideration during the various tests from both the experimental and practical view points. The inhibitory effects of the various treatments and procedures were observed over two to twenty-four day periods. Tissue coming from various parts of the fish was found to cause a difference in the development of mold. The more oily pieces were found to foster mold growth more readily than those of average composition. The wrapping of individual pieces was found to be somewhat unsatisfactory because the extra handling caused varying amounts of contamination and subsequent spoilage.

As was expected, the best time for the treatment of the fish was in combination with the brine. Salmon dipped in very weak solutions of benzoates was not affected but when it was dipped in 0.10 percent benzoic acid plus 0.10 percent sodium benzoate good results were obtained, while salmon dipped in 0.15 percent benzoic acid plus 0.15 percent sodium benzoate gave very good results. All of the benzoate-benzoic acid combinations were used with a forty degree brine (10%). Unwrapped pieces kept for twenty-one days having been dipped at this latter concentration. The other dips showed a greater variation in keeping qualities, some showing mold from the first day to four days after mold developed on the controls (untreated pieces). Kippered salmon wrapped in cellophane did not keep as well in any of the dips due to the retention of surface moisture and contamination during handling. Silverside salmon treated in the same manner, except not wrapped, developed mold at the end of two weeks with the lower concentration dip. The latter concentration inhibited mold growth during a three-week holding period.

One series of tests was made by dipping Chinook salmon for two minutes in concentrations of 0.5, 0.7, and 1.0 percent Brino (a commercial preparation composed of equal parts of magnesium benzoate and benzoic acid) after the fish had been salted. All pieces in this series including the control developed mold on the fourth day, thus demonstrating the advantage of using the benzoates with the brine, a fact previously established in the studies on fresh fillets.

Twelve pieces of Chinook salmon were dipped for two minutes in concentrations of 0.15 percent sodium benzoate plus 0.15 percent benzoic acid plus 5.0 percent salt after smoking and cooling. The controls developed mold at the end of the third day. Only one piece had not developed mold after a six-day storage period. Samples of Chinook salmon were dipped for two minutes in 0.15, 0.25, 0.35, and 0.5 percent Brino in 5.0 percent salt immediately after smoking and before the fish was allowed to cool to observe the effect of adding the benzoates at this time. Several pieces developed mold before the controls. All pieces developed mold by the fifth day. These few data and the impaired appearance of the fish demonstrated the impracticability of the dip after smoking.

#### General Recommended Procedure

It has been found that the addition of small amounts of benzoic acid and either sodium or magnesium benzoate to the brine in which the fish is to be salted is advantageous in preventing mold growth in the finished kippered product during the storage period before utilization. In order to attain a thorough mixing of the benzoates in the brine, it is suggested that a small portion of the total water or brine be heated to dissolve the benzoate crystals or powder. This solution is then stirred into the larger portion of water or brine.

Concentrations of between 0.3 and 0.5 percent of the benzoate combination (equal parts of benzoic acid and sodium or magnesium benzoate) are recommended for use in this brining or salting operation.

For Example:

Per 10 gallons of brine-

Use 3.8 oz. of combination to give a 0.3 percent solution.

Use 6.4 oz. of combination to give a 0.5 percent solution.

### Conclusions

Benzoates inhibited microorganisms by their action on kippered fish. The activity was enhanced by increasing the hydrogen-ion concentration by means of adding acid. The inhibiting effect of this combination was enhanced by the addition of it to the brine.

Sodium and magnesium benzoates gave equal protection against spoilage and when either of these two salts was present with benzoic acid a pronounced inhibiting effect was found. Concentrations between 0.1 and 0.15 percent inhibit and do not produce objectionable flavors in fresh fillets, while concentrations between 0.15 and 0.7 percent can be similarly used on kippered fish.

Dips as long as ten minutes were not injurious to the tissue of the fresh fillet, but did not increase the inhibiting effect proportionately. Dips of one to two minutes were found to produce satisfactory inhibition. In the kippered fish procedure the benzoate treatment prior to brining was not satisfactory, nor was the benzoate combination sufficiently absorbed after brining. The optimum results were obtained when the benzoate combination was put into the brining solution. The action of the sodium chloride brine in both the fresh and the kippering procedures tends to firm the tissue and aid the benzoate activity.

Studies of the retention of the benzoates showed that the amounts used to gain satisfactory inhibition would not be injurious to the well-being of the consumer of these products.

Bacteriological studies of kippered fish with benzoate treatment correlated well with the taste tests and showed that fish tissues could be preserved by this method during a longer period than that found in currently used methods.

### Summary

1. Benzoic acid and some of its salts exert an inhibiting effect on bacteria in the preservation of fish tissue.
2. A combination of sodium or magnesium benzoate and benzoic acid has been found to be more efficient in inhibiting bacterial growth than other benzoate salts and the acid.
3. The addition of sodium chloride has been shown to aid the action of the combination (2) upon the bacteria.
4. The amount of benzoates retained by the fish tissue from the solutions studied in the investigation neither impair flavor nor are otherwise detrimental to the preserved tissue, or to the health of the consumer.
5. The optimum time for treating kippered fish is during the brining process.
6. Concentrations of the combination (2) between three-tenths and seven-tenths percent are found to effect satisfactory inhibition of bacteria without impairing flavor, taste, and color, in kippered fish.
7. Benzoates are best put into solution by heating in a small amount of the total water or brine to be used.

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