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Improving the Acceptability of Intermediate-Moisture Fish

H.A. DYMSZA and G. SILVERMAN

□ THE TECHNOLOGY of processed intermediate-moisture (IM) foods has advanced to the state where there is substantial knowledge of production concepts, enzyme reactions, physico-chemical changes, and microbial behavior related to food preservation (Duckworth, 1975; Gee et al., 1977; Troller and Christian, 1978).

With a moisture content of 20-50% and a water activity (a_w) ranging from 0.9 to 0.7, IM foods offer the unique advantages of a soft, plastic texture and the ability to resist bacterial growth when stored under non-refrigeration conditions, even at temperatures above 40°F. Furthermore, careful adjustment of a_w, heat-processing to inactivate enzymes, use of moisture-proof packaging, and use of additives such as antimycotic agents and antioxidants can reduce non-bacterial deleterious changes (Karel, 1973).

Infusion into the food product of low-molecular-weight solutes such as NaCl and sucrose and humectants such as glycerol and propylene glycol to reduce a_w has been described by Brockmann (1970) and Kaplow (1970). In one procedure, infusion is accomplished by hydrating a dried food in an aqueous solution of solutes and humectants until the food reaches a proper moisture content and a_w level. Another method is to facilitate desorption of water and infusion of solutes by equilibrating a moist food in a solution of lower a_w; the procedure involves cooking the food in an infusion solution, then equilibrating the cooked food under refrigeration for several hours or overnight.

In spite of having potential for application to food products, commercial development of fabricated IM foods has been limited to pet foods. The problem is essentially one of low palatability or acceptance. Troller and Christian (1978) have concluded that development of fabricated IM foods for human consumption has been impeded by the lack of suitable humectants which do not impart an objectionable taste. With this in mind, we initiated research on procedures for removing most of the infusion solution flavor before consumption.

METHODS DEVELOPED

The study resulted in (1) a rapid method for producing IM fish by cooking in an infusion solution and (2) a method for improving flavor prior to consumption by desorptive removal of the infused solutes.

• **Infusion Method.** Fresh flounder fillets were cut into pieces approximately 2.7 cm × 2.7 cm × 1.3 cm, put into a colander, and lowered into an infusion solution which had been heated to 90°C. The proportion of fish to infusion solution was 1:3. The infusion solution consisted of 40% glycerol, 10% sodium acetate, 7% sodium chloride, and 43% distilled water. Cooking was continued for 20 min. After cooking, the IM fish product was drained for 30 min, weighed, packed into sterile polyethylene bags, and stored at 20°C.

Total aerobic plate counts were taken of the raw unprocessed fish and of the cooked IM fish periodically from 3 to 87 days of storage. At each time, two samples were used. In the microbiological analysis, each 20-g sample was mixed with 180 ml of tryptone broth at pH 7 and homogenized by Stomaching for 2 min. Serial dilutions were made, and 0.1-ml aliquots were spread on prepared dishes of plate-count agar. Incubation was for 3-5 days at 20°C.

The water activity was determined at 24°C with a dew-point hygrometer. The IM fish had a mean a_w of 0.82. This was low enough to inhibit the growth of almost all bacteria. In 87 days of storage at 20°C, the microbial population did not exceed 540 colony-forming units/g (Table 1). As may be expected, some but not all mold growth was prevented. However, mold growth was visible in only one sample.

• **Desorption Method.** In an attempt to remove most of the objectionable flavor imparted by the infusion solution, the IM fish was boiled in water (1 part fish to 3 parts water by weight) for 15 min. The resulting product, termed "IM desorbed (IMD) fish" and a control sample of plain boiled fish were evaluated for overall acceptance by a taste panel composed of staff members and graduate students, using a 9-point hedonic scale. All samples subjected to taste panel testing were freshly prepared.

Whereas taste panel evaluations indicated that the IM fish sample was disliked (mean acceptance rating of 2.7), the IMD fish, which had much of the infusion solution removed, received a mean rating of 4.7 (Table 2). This rating was similar to the 4.9 value for boiled fish. As it had been previously shown by Dymsza et al. (1976) that flavorful sauces could increase acceptance of IM fish, both boiled and IMD fish were also served with a commercial spicy seafood cocktail sauce. With both samples, the ratings advanced (as shown in Table 2) from about 5.0 (neither like nor dislike) to about 6.0 (like slightly).

Author Dymsza, Professor of Food Science and Technology at the University of Rhode Island, is currently on assignment with the Bureau of Foods, Food and Drug Administration, Room 1816, HFF 265, 200 C St., S.W., Washington, DC 20204. Author Silverman is Food Microbiologist, Food Science Laboratories, U.S. Army Natick Research and Development Command, Natick, MA 01760

Table 1—**TOTAL AEROBIC PLATE COUNTS** *of infusion-cooked intermediate-moisture fish and a control*

Product	No. of days at 20°C	No. of colony-forming units/g
Control (unprocessed fish)	0	140,000
IM fish	3	320
	10	380
	17	540
	32	100
	57	350
	87	180

In another round of taste-panel tests, acceptance increased markedly when the boiled fish and the IMD fish were coated with a fish-batter mix and deep-fat fried at 375°F. As shown in Table 3, the mean ratings for the boiled fish increased from 3.4 (dislike moderately) to 6.8 (like moderately), and the mean ratings for the IMD fish increased from 5.8 (like slightly) to 7.8 (like very much).

ALLOWS FORMULATION VERSATILITY

Other than rapidity of preparation, an advantage of the combined infusion and desorption process is that it permits experimentation with a wide variety of infusion solution formulations, because of less concern over initial flavor. We have developed several formulations which are suggested as models for IM foods in developing countries. A typical infusion solution for this purpose consists of only 32% sucrose, 7% NaCl, and 61% water. Initially, the IM fish has a strong, objectionable, sugar-salt flavor. After desorption, the product still has a faint taste of sugar and salt, but is quite acceptable.

The procedure can also be used for the preservation of other high-moisture foods such as meat, poultry, and vegetables.

An obvious disadvantage is that the removal of the infusion solution by desorption represents an additional step in preparation before consumption. The infusion solution also requires considerable quantities of solute (32% sugar in the above example). However, it appears to be possible to develop procedures which would make it possible to re-use the solutes or the infusion solution, and thus reduce cost.

Table 2—**ACCEPTABILITY OF IMD FISH** *(IM fish boiled in water to remove infused solutes) and a control, served with and without seafood cocktail sauce*

Product	No. of tasters	Acceptance score[a] (mean ± standard deviation)
Control (boiled fresh fish)	13	4.9 ± 2.1
Control + sauce	13	6.0 ± 1.6
IMD fish	13	4.7 ± 1.5
IMD fish + sauce	13	6.2 ± 1.4

[a]Based on a 9-point hedonic scale: 1 = dislike extremely; 9 = like extremely

[b]IM fish was disliked moderately (mean acceptance rating of 2.7)

Table 3—**ACCEPTABILITY OF DEEP-FAT-FRIED IMD FISH** *and a control*

Product	No. of tasters	Acceptance score[a] (mean ± standard deviation)
Control (boiled fresh fish)	10	3.4 ± 1.6
Fried control	10	6.8 ± 1.6
IMD fish	10	5.8 ± 1.4
Fried IMD fish	10	7.8 ± 0.9

[a]Based on a 9-point hedonic scale: 1 = dislike extremely; 9 = like extremely

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