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REDUCTION OF CURD IN CANNED SALMON PREPARED FROM FROZEN FISH

Part II - Effect of pH and Salt Content

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ABSTRACT

The liquid-binding power of fish muscle is influenced by salt content and pH and exhibits a zone of minimum effect corresponding to the "isoelectric zone" (approximately pH 5 to 6) of fish-muscle proteins. The retention of fluid on heat processing, with corresponding curd reduction, was shown to depend upon the liquid-binding power of the proteins at approximately pH 6.5 and above in the presence of about 2- to 5-percent salt in the meat. These findings do not support the hypothesis that the reduction of curd formed during the heat processing of brined meat (prepared from frozen fish) is due to a dissolving action of brine on the meat proteins.

INTRODUCTION

Chief among the undesirable characteristics of canned salmon prepared from thawed fish is a surface curd formation as a result of the heat coagulation of soluble protein released during heat processing. It has been observed that treatment of the thawed meat, prior to heat processing, with 70-percent saturated brine for 10 min-

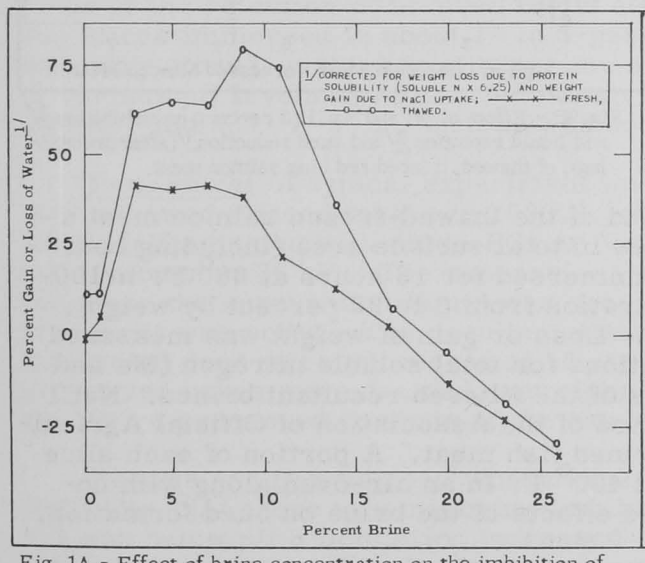

Fig. 1A - Effect of brine concentration on the imbibition of water by fresh and thawed king salmon slices.

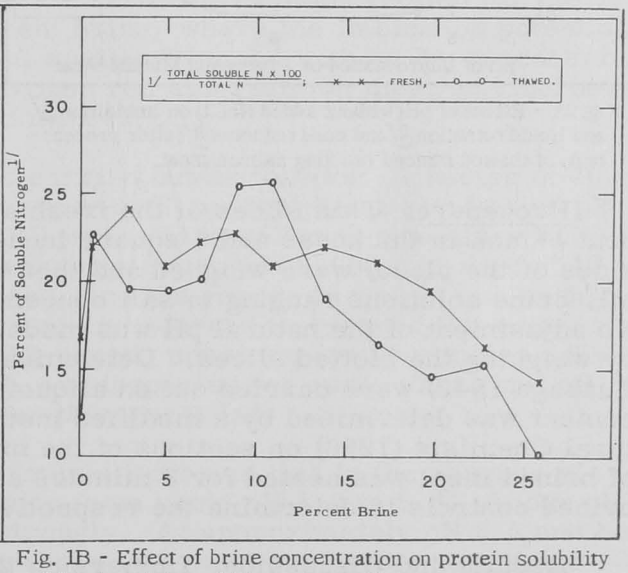

Fig. 1B - Effect of brine concentration on protein solubility of fresh and thawed king salmon slices.

utes is partially effective in reducing curd (Dassow and Craven 1955). Tanikawa et al. (1952) have proposed that the reduction of curd formed during the heat processing of brine fish meat is due to a dissolving action of brine on the meat proteins, and these authors have suggested, for the prevention of curd, as complete a removal of soluble proteins from the surface of the meat as possible.

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It is well known, however, that brine treatment of the meat prior to freezing or after thawing markedly reduces drip and that this treatment is thus quite effective in preventing the excessive loss of soluble protein. Tarr (1942) has demonstrated that the prevention of drip occasioned by lightly brining fresh and thawed fish muscle at its natural pH is due largely to the ability of NaCl to cause the proteins to bind liquid firmly. Tarr also reports that halibut muscle swells gradually in dilute HCL or NaOH solution, the swelling in acid being almost entirely inhibited by NaCl and that in alkaline solution greatly increased thereby.

In an attempt to explain the effect of brine on fish meat in reducing drip and the curd resulting from heat processing, the general proposals of Tanikawa et al. and Tarr of protein solubility and protein swelling in brine have been considered in the present brining studies.

EXPERIMENTAL

EFFECT OF NaCl CONCENTRATION ON PROTEIN SOLUBILITY, IMBIBITION, AND CURD REDUCTION: Both fresh and thawed-frozen red king salmon (Oncorhynchus tschawytscha) were used. (Prior to the tests, the frozen salmon were held in storage at -20° F. for 3 weeks.)

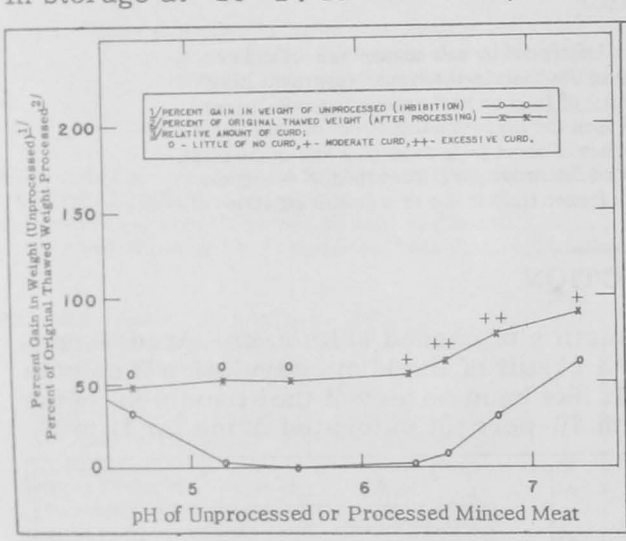

Fig. 2A - Effect of pH (without added NaCl) on imbibition 1/ and liquid retention 2/ and curd reduction 3/ (after processing), of thawed minced red king salmon meat.

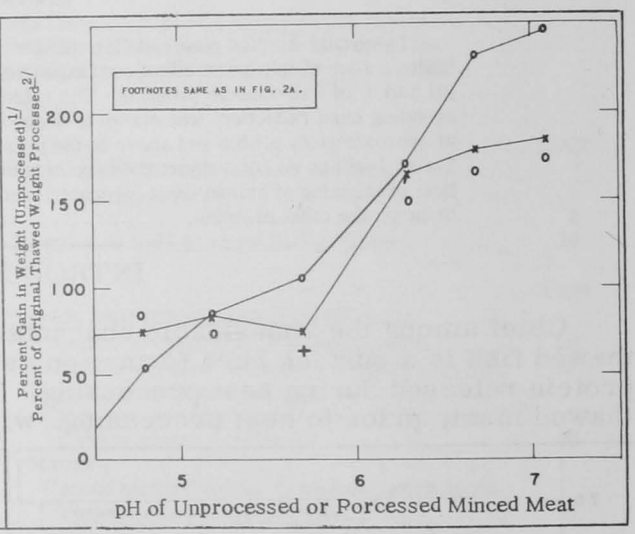

Fig. 2B - Effect of pH and NaCl (3 percent) on imbibition 1/ and liquid retention 2/ and curd reduction 3/ (after processing), of thawed, minced red king salmon meat.

Procedure: Thin slices of the fresh and of the thawed-frozen salmon meat about $\frac{1}{8}$-inch in thickness and 4 square inches in total surface area (including both sides of the piece) were weighed and then immersed for 16 hours at 68° F. in 100-ml. brine solutions ranging in salt concentration from 0 to 26 percent by weight. No adjustment of the natural pH was made. Loss or gain of weight was measured by weighing the blotted slices. Determinations for total soluble nitrogen (Ma and Zuazaga 1942) were carried out on aliquots of the filtered resultant brines. NaCl content was determined by a modified method of the Association of Official Agricultural Chemists (1950) on sections of the brined fish meat. A portion of each slice of brined meat was heated for 2 minutes at 450° F. in an air-oven along with unbrined controls to determine the respective effects of the brine on curd formation.

Results and Discussion: Immersing the thawed-frozen meat in brine reduced curd formation only if the brine was of certain concentrations (table). If the concentrations were between 1 and 5 percent there was little or no curd formation. Above these concentrations, there was an increasing tendency for the meat to lose imbibed water on heating (with resulting formation of curd) up to a maximum at about

17 to 20 percent brine concentration. Above this level, increasing dehydration of the fish meat occurred with resulting protein denaturation, and little curd was observed on heating. The attainment of equilibrium between meat and water was not demonstrated, however, and the dehydration effect beyond the point of maximum imbibition may not have reached completion (Fougère 1952).

Relationship of Brine Concentration to Curd Formation on Fresh and Thawed King Salmon Slices Immersed in Brine and Then Heated

Sample	Amount[1/] of Curd on Control	Amount of Curd on Brined Slices — Brine Concentrations--Percent											
		0	1	3	5	7	9	11	14	17	20	23	26
Fresh	0	0	0	0	0	0	0	0	0	0	0	0	0
Thawed	+	+	0	0	0	+	+	+	++	++	++	0	0

1/ 0 - little or none; + - moderate; ++ - excessive

The fresh tissue showed no significant curd on heating, regardless of the NaCl concentration (table).

The tests for imbibition (fig. 1A) and solubility (fig. 1B) were interesting in that the frozen tissue showed a much greater inbibing power than the fresh tissue (Tarr 1942), maximum imbibition occurring at the point of maximum solubility for the protein of the thawed tissue. Except at this point (about 10-percent brine) the thawed tissue essentially showed a slightly lower solubility than the fresh (Snow 1950).

The relatively poor curd prevention in the region of maximum solubility of the protein of the thawed meat would not seem to indicate an obvious relationship between leaching effects of the brine and curd reduction as proposed by Tanikawa et al. (1952). In addition, the curd prevention at high NaCl concentrations, where protein solubility is at a minimum, is due to a dehydrating effect rather than to a leaching effect.

The fact that king-salmon meat shows an imbibition maximum at about 10-percent NaCl is in agreement with the findings of Fougère (1952) and Duerr and Dyer (1952), who used cod muscle. The latter authors showed that it is the actomyosin fraction that undergoes denaturation above this NaCl concentration.

EFFECT OF pH AND NaCl ON IMBIBITION AND CURD REDUCTION: On the basis of the retention of imbibed liquid and the resulting curd prevention for the tissue slices immersed in about 1- to 5-percent brine, where the imbibition potential was very strong, a number of experimental studies with and without 3-percent brine at various pH levels were carried out on frozen red king-salmon meat that had been stored 9 months at -5° F. then thawed and minced.

Procedure: A typical experiment was carried out as follows: A series of 40 g. of the thawed minced meat per 200 ml. of water or 3-percent brine at adjusted pH levels (pH adjusted with dilute HCl or NaOH) was held in 250-ml. centrifuge bottles for 16 hours at 36° F. The suspensions were centrifuged at 2,000 r.p.m. for 20 minutes, the supernatant liquid was decanted, and the change in weight due to this treatment was noted. The resultant meat was transferred to $\frac{1}{2}$-pound flat cans, and the sealed cans were processed at 10- to 12-pounds pressure for 40 minutes. The processed cakes were drained, reweighed, and inspected for curd. The final pH of the entire processed contents of the can was then recorded.

Results and Discussion: These experiments indicated that in the absence of NaCl (fig. 2A) there was minimum imbibition from about pH 5.2 to 6.3. Above pH 6.5 and below pH 5 imbibition increased strongly. At approximately pH 5.5 and below there was no curd on heat processing; above this point curd was present and particularly heavy in the region of about pH 6.5 to 7.

In the presence of 3-percent brine (fig. 2B), imbibition was at a minimum below pH 5, becoming quite strong between pH 5 and 6, and very strong from pH 6 to at least 7.1. On heat processing there was no curd below pH 5, and there was mod-

erate curd intermediate between pH 5 and 6. In the range of approximately pH 6.5 to at least pH 7.1, there was a complete lack of curd. In addition, the presence of 3-percent brine at approximately pH 6.5 and above greatly increased the ability of the meat to retain imbibed liquid on processing, liquid retention being closely related to curd prevention.

Thus, the retention of extra-cellular fluids or drip is related to the power of the proteins to imbibe free liquid. This imbibing power of muscle proteins is influenced by salt content and pH and exhibits a zone of minimum effect corresponding to the "isoelectric zone" (approximately pH 5 to 6) of fish muscle proteins (Tarr 1942). The retention of fluid on processing, with corresponding curd reduction, depends upon the liquid-binding power of the proteins at approximately pH 6.5 and above, occasioned by the presence of about 2 to 5 percent salt in the meat.

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DO YOU KNOW THAT

An 80-year old Norwegian fishermen of Kjelvik in Finnmark Province in the spring of 1954 caught a halibut weighing 154 pounds. He rowed 1½ hours to Honningsvaag to sell his catch.

--News of Norway, May 27, 1954.