Progress on Projects, January 1954

VITAMIN CONTENT AND NUTRITIVE VALUE OF FISHERY BYPRODUCTS: Information on the proximate composition and vitamin content of fish meals has been presented in these progress reports as the data became available. For comparative purposes, a summary of the data collected to date is presented in the following table. In the table, where possible, average results as well as the range of values are given.

Proximate Composition and Vitamin Content of Fish Meals								
Description of Samples		Proximate Composition				Vitamin Content (Moisture-and-Oil Free Basis)		
Meal	Number of Samples Analyzed	Value	Moisture	Protein	Oil	Riboflavin	Niacin	Vitamin B_{12}
			Percent	Percent	Percent	Micrograms per Gram	Micrograms per Gram	Micrograms per Gram
Sardine	23	Average	8.0	60.4	7.9	5.4	86	0.27
		Maximum	10.6	69.4	10.8	7.2	125	0.38
		Minimum	3.5	55.6	6.7	4.2	61	0.20
Sardine	16	Average	8.2	-	7.5	4.1	63	0.25
		Maximum	13.3	-	8.6	5.6	80	0.29
		Minimum	3.5	-	6.7	2.4	42	0.22
Tuna	22	Average	6.9	62.7	9.8	7.2	152	0.33
		Maximum	14.4	67.2	15.7	8.3	201	0.41
		Minumum	3.2	52.5	7.1	4.2	67	0.22
Menhaden	24	Average	9.2	59	9.5	4.0	66	-
		Maximum	10.8	65.9	13.5	7.0	91	-
		Minimum	7.2	50.1	6.5	2.6	42	-
Whale loin	3	Average	7.7	-	16.9	10.6	128	0.079
Mackerel	4	Average	9.7	-	7.9	5.8	66	0.43
Anchovy	1	-	3.1	-	7.6	4.7	41	0.14
Crab	6	Average	8.8	30.1	2.9	7.9	37	-
		Maximum	10.7	34.1	3.8	9.8	40	-
		Minimum	7.2	27.2	2.3	0.9	36	-
Herring	4	Average	11.1	-	9.9	7.5	70	0.32

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SULFIDE DISCOLORATION IN CANNED TUNA (Period covered--from July through December 1953): The purpose of this project is to determine why some batches of tuna tend to cause sulfide discoloration of the cans. A study is being made of the reaction mechanism whereby iron sulfide is formed during the canning of tuna and of the factors which favor the reaction. This work includes a study of the compounds acting as a source of sulfide sulfur in tuna and the effect of such conditions as pH and spoilage of the flesh on the sulfide discoloration of the cans.

In order to form black iron sulfide in cans of tuna, sulfide sulfur must come in contact with the iron of the can under conditions favorable for the chemical reaction to occur. Sulfur occurs in fresh fish in a form other than sulfide. It is present in such amino acids as cystine and methionine which make up a portion of the fish proteins. During spoilage of fish, a part of the sulfur is converted to the sulfide form. If this fish were canned, the sulfide would be available for reacting with any exposed iron in the can. For such a reaction to take place, however, certain other conditions, e.g. the optimum pH, must be present.

The effect of condition of the fish upon sulfide discoloration is being investigated to determine whether the sulfide comes directly from the fresh fish protein or from the degradation products that form from the protein. Other factors which might be important to the reaction of sulfide with iron (e.g. the pH of the fish) are being studied. The effects of variations in the processing procedures are also being considered.

The results so far seem to indicate that:

1. The degree of spoilage of tuna used for canning is only a minor factor in can discoloration.

2. The amount of precooking of tuna has little effect on can discoloration.

3. There is some possibility that the pH of the tuna may play an important role in can discoloration. (This point is being further investigated.)

4. Sulfides are present in fresh tuna both in bound form and as free hydrogen sulfide, the amount increasing with spoilage.

5. Essentially all of the sulfur present in the form of sulfide in the fresh fish is driven off during the precook period. (This occurred even with fish that were given a much shorter precooking period than is normally practiced commercially.)

6. Sulfides are found in the canned product. (Since the fish packed into the cans were free of sulfide, the sulfides in the canned fish must have been formed during the final heat processing.)

7. The sulfides formed during the heat processing probably come from the high molecular weight protein fraction of the tuna meat.

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CHEMICAL AND PHYSICAL PROPERTIES OF FISH AND SHELLFISH PROTEINS: Additional data were obtained with frozen rockfish to obtain a comparison of the amount of drip produced from frozen fillets when cooked (1) after thawing and (2) while frozen. The tests were made during periodic intervals of frozen storage of the fillets so as to observe the effect of storage conditions on drip formation. The results are summarized in the following table:

Samples of Frozen Fillets		Loss in Weight			
		Thawed Fillets			Frozen Fillets
Species of Fish	Storage Time at 0° F.	As Drip Formed During Thawing	As Evaporation and Drip Formed During Cooking1/	Total	As Evaporation and Drip Formed During Cooking1/
		Percent	Percent	Percent	Percent
Rockfish	7	1.4	21.8	22.8	20.4
	29	2.2	22.8	25.0	19.8
	132	3.1	21.5	24.6	16.9
	213	1.6	17.5	19.1	11.2

NOTE: THE FRESH FILLETS SHOWED A 22.0 PERCENT LOSS (AS EVAPORATION AND DRIP) DURING COOKING (BAKED AT 350° F. FOR 23 MINUTES).

1/FOR THE COOKING TESTS, THE SAMPLES WERE BAKED AT 350° F. FOR 23 MINUTES FOR THE THAWED FILLETS AND 33 MINUTES FOR THE FROZEN FILLETS.

(Seattle)

TECHNICAL NOTE NO. 29--EFFECT OF SALT ON THE STORAGE LIFE OF SALMON EGGS PRESERVED WITH SODIUM BISULFITE

INTRODUCTION

Research by the Service's Fishery Technological Laboratory at Seattle, Washington, and the U. S. Fish and Wildlife Service hatchery at Leavenworth, Washington, has shown that salmon eggs are an excellent feed for hatchery fish (Robinson, Palmer, and Burrows 1951). Large quantities of these eggs are available each year in Alaska during the short but highly intensive canning season. How to preserve the eggs until they can be delivered to the hatchery is a problem. The best method would be to freeze them, but most Alaskan canneries do not have the required facilities.

A promising alternative method would be to preserve the eggs by means of a chemical. This method would have definite advantages. For instance, the expense of freezing and cold storage would be eliminated. Furthermore, any cost of transporting the eggs from Alaska would be reduced, since the cost of transportation is considerably lower for unfrozen than for frozen products. The price of the chemical, technical-grade sodium bisulfite ($NaHSO_3$), used to preserve the eggs is not high. It costs only 0.1 cent per pound of eggs preserved if used at the 0.5-percent level (0.5 pounds of sodium bisulfite per 99.5 pounds of eggs).

In work reported by Pigott and Stansby (1952), the use of 0.5-percent sodium bisulfite proved successful in preserving salmon eggs for approximately three months. In conjunction with this work, feeding tests were carried out at the Leavenworth Hatchery (Burrows, Robinson, and Palmer 1952) using eggs preserved by 0.5-percent sodium bisulfite. These tests showed no adverse effect from sodium bisulfite, except that it destroyed thiamine.

During the summer of 1951 a large-scale collection of salmon waste was made at a cannery in Petersburg, Alaska (Landgraf, Miyauchi, and Stansby 1951). At that time 5,000 pounds of salmon eggs were preserved in 30-pound slip-cover berry tins with 0.5-percent sodium bisulfite. These eggs were then shipped to the fish hatchery at Leavenworth, Washington. Upon arrival they were found to be spoiled.

The only known explanation for the spoilage was that the slight amount of salt (sodium chloride, NaCl) picked up by the eggs when they were flumed with sea water at the cannery may have accelerated the rate of decomposition. The reason for believing that salt may have contributed to the spoilage was that in earlier tests at the Seattle Technological Laboratory it was qualitatively observed that salt did decrease the preservative effect of sodium bisulfite.

In order to obtain quantitative data on how much the presence of salt affects the action of sodium bisulfite in the preservation of salmon eggs, the following experiment was run.

PROCEDURE

Salmon eggs were collected at Ketchikan, Alaska, from a cannery where fresh water was used for fluming the salmon waste to conveyor belts. A mixture of eggs from mature chum salmon (Oncorhynchus keta) and pink salmon (Oncorhynchus gorbuscha) were used. Chum salmon eggs made up approximately 80 percent of the total. The eggs were picked directly from a conveyor that carried the salmon waste from the "iron chinks" (machine for removing waste portions from salmon) to the gurry bins. After the eggs were drained and placed in containers, they were brought to the Laboratory where two series of preserved salmon eggs were prepared.

In series I, an empty 30-pound berry tin was placed on a scale adjusted for the gross weight of tin, plus eggs and chemical. The preservative (sodium bisulfite) was weighed into a beaker. Then a portion was sprinkled from the beaker onto the bottom of the tin. Next a scoop with a capacity of approximately 5 pounds was used to transfer the salmon eggs to the tin. After each scoop of eggs was added, a small amount of preservative was sprinkled in. When approximately 15 pounds of salmon eggs had been placed in the tin, the added sodium bisulfite was mixed in thoroughly. Finally, after the tin was filled with 30 pounds of eggs, the contents were again mixed.

Five of the tins thus prepared made up a "lot," and there were 4 lots in each of the 2 series. The only variable between the lots was the concentration of sodium bisulfite, which was as follows:

Lot Number	Concentration of Sodium Bisulfite
	Percent
IA	0.25
IB	0.50
IC	0.75
ID	1.0

Series II was identical to Series I with the exception that 2-percent salt was added in addition to the sodium bisulfite. The salt and sodium bisulfite were weighed into a beaker and mixed prior to being added to the salmon eggs.

Both series of preserved eggs were stored in an unheated building at the rear of the Laboratory at temperatures ranging from 35° F. to 60° F. and averaging 50° F.

One tin of eggs from each lot was inspected at the end of 2, 4, 7, 10, and 15 weeks for surface mold, odor, color, general condition, and free liquid. If spoilage was evident, the remaining tins in the lot were opened. Once a tin was inspected, its contents were discarded.

RESULTS

The storage life of the various lots of chemically preserved salmon eggs is given in the following table.

Effect of Sodium Chloride on the Storage Life of Salmon Eggs Preserved with Sodium Bisulfite

Lot Number	Amount of Sodium Bisulfite	Amount of Sodium Chloride	Storage Life
	Percent	Percent	Weeks
IA	0.25	0	2
IIA	0.25	2	2
IB	0.50	0	10
IIB	0.50	2	2
IC	0.75	0	15
IIC	0.75	2	greater than 15
ID	1.0	0	greater than 15
IID	1.0	2	greater than 15

NOTE: ALTHOUGH IIC, ID, AND IID WERE ALL IN ACCEPTABLE CONDITION AT THE END OF 15 WEEKS OF STORAGE, THERE WAS A MARKED DIFFERENCE IN THE APPEARANCE AND GENERAL CONDITION OF THE PRESERVED SALMON EGGS FROM THESE THREE LOTS. THEY WERE RATED IN THE ORDER IID, IIC, AND ID, WITH IID BEING THE BEST.

With 0.25-percent sodium bisulfite, there was no marked preservative action with or without the addition of 2-percent salt.

With 0.5-percent sodium bisulfite, there was definite preservative action. However, the presence of 2-percent salt with the 0.5-percent sodium bisulfite had an adverse effect on the keeping quality of the eggs. The eggs preserved with 0.5-percent sodium bisulfite had a much longer storage life (10 weeks) than did those preserved with 0.5-percent sodium bisulfite plus 2-percent salt (2 weeks). More free liquid was present in those tins to which the salt had been added. It was in this liquid that putrefaction was first evident.

With 0.75-percent or 1.0-percent sodium bisulfite, the presence of 2-percent salt had no adverse effect on the keeping qualities of the eggs. In fact, addition of salt with these concentrations of sodium bisulfite greatly reduced the amount of mold in the eggs at the top of the containers and tended to prevent the separation of the eggs from the skeins.

Thus, the results of this experiment indicate the following:

1. With sodium bisulfite concentrations (0.25 percent) less than sufficient to preserve the eggs (0.25 percent), the addition of 2-percent salt does not appreciably affect their storage life.

2. With sodium bisulfite concentrations (0.5 percent) just sufficient to preserve the eggs, the addition of the salt (2 percent) decreases their storage life.

3. With concentrations somewhat greater (0.75 or 1.0 percent) than just sufficient to preserve the eggs, the addition of salt (2 percent) tends to increase their storage life and has a beneficial effect on their appearance and general condition.

DISCUSSION

The results of this experiment are based on the preservative action of sodium bisulfite and salt on only 1,200 pounds of salmon eggs taken during a single season from but one cannery. The findings in a similar experiment carried out under somewhat different conditions may vary from those reported here.

However, the results of this one experiment do indicate that salmon eggs can be preserved in breather-type containers by 0.75- to 1.0-percent sodium bisulfite plus 2-percent salt for as long as 15 weeks or more at an average temperature of 50° F. (Earlier work has shown that a much longer storage life may be expected if hermetically sealed containers are used.)

Since earlier work (Burrows, Robinson, and Palmer 1952) indicated that sodium bisulfite, even at the 0.5-percent level, will destroy thiamine, feeding tests should be made using eggs preserved with 0.75- to 1.0-percent sodium bisulfite (with and without 2-percent salt) and containing added supplements of thiamine to determine whether these amounts of preservatives are feasible for use with eggs fed to hatchery fish.

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