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BACTERIAL POPULATION OF BRINING TANKS IN FISH FILLETING PLANTS

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ABSTRACT

The data indicate that brining tanks used in washing fish fillets can be an important source of contamination. Manual control of chlorine and salt concentration of brine was not effective to maintain continuously the desired levels. Automatic control is recommended. Some means should also be used to remove the debris continuously.

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INTRODUCTION

Shortly after the Boston Technological Laboratory acquired its mobile laboratory unit, sea food producers in the New England area requested that "on the spot" studies of their filleting process methods be undertaken. Previous to initiating studies, a number of producers were interviewed to determine what steps in the processing needed particular attention. From the interviews, it became quite apparent that the brine solutions through which the fish fillets pass before packaging were of particular concern to all, primarily from the bacteriological standpoint.

FACTORS CONCERNING THE BRINING OF FISH FILLETS

Brining tanks in fish filleting plants serve a fourfold purpose; namely:

1. To condition fillet surfaces so that the "drip" during thawing of the frozen product be reduced.

2. To lessen the tendency of the fillets to adhere to one another in the packaged product.

3. To clean the fillets physically from unavoidable slime and fish scales collected in the filleting operations.

4. To reduce the bacterial load of the fillets by the washing effect of the brine.

The latter would be highly important should freezing of the packaged fillets be delayed or the shipment be made as chilled fillets.

Brine strength and brining time vary according to the species of fish handled to insure optimum results. For example, Stansby and Harrison (1942) found that brining for 20 seconds in 15 percent brine (60^{o} salinometer) reduced the drip of frozen Cape sole (low fat content) fillets from 6 to 2 percent. The average leak-

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age of unbrined, quick-frozen silver salmon was 1.8 percent; whereas that of the brined product was 0.4 percent. Brined pink salmon (high fat content) fillets stored at -5° F. were slightly rancid after two months, although unbrined fillets were still fresh, indicating that brining hastened the development of rancid flavors in fat fish and should be avoided. Lemon (1947) advocated a brine strength of 25° to 35° salinometer and the use of chlorine to the amount of 3 to 5 parts per million. Maintenance of this concentration of chlorine and holding the temperature of the brine at 35° to 45° F. were thought to be important if the fillets were not to be damaged during the brining operations.


BRINING TANK

Vucassovich (1947) designed an apparatus for simultaneously conveying, washing, brining, and precooling food products for freezing. In brining fish fillets, a brine with 12 to 14 percent salt is used. Chilled brine is circulated through stainless steel flumes which convey the fillets to the brining tank whence an elevator conveyor directs the fillets to the packing table. Absorption of salt concentration is almost constant over a 5- to 30-second contact. Consequently, there is no material difference in the amount of salt taken up by fillets dropped in flumes at varying distances from the tank. Brine is changed at intervals of two hours. A system of this type eliminates the possibility of uneven brining that sometimes occurs in static brine when fillets clump together. It would also adapt itself to continuous automatic chlorination of the brine and automatic regulation of density.

Spartales (1938) found major contamination of the filleting boards and belt in a fish filleting line to occur just previous to the brining tank; also that fillets often go through brining tanks without a residual of chlorine in the brine when manual chlorination has been applied to the tanks.

Although much work has been done on the effect of brining on the physical structure of fish fillets, very little work has been reported on the bacteriology of brining tanks. This paper discusses the brining tanks from the standpoint of bacteriological population.

OPERATIONS OF THE FISH FILLETING PLANT

The plant in which most of this work was carried out operated in a manner typical of most filleting operations in the New England fishing industry. Fish, iced and gutted, were received from carts loaded from trawlers. Placed into a bin which acted as a hopper for a conveyor, the fish were led to mechanical scalers and were washed. After being cut, the fillets were conveyed to a trimming table where they were trimmed and, if skinless fillets were being prepared, were skinned. The finished fillets were conveyed through a 50-gallon stainless steel brining tank to a drain board and subsequently packaged.

The brine was renewed at 2-hour intervals. All plant equipment was washed down and the lines flushed with fresh water as the brine was being changed. Saturated brine was prepared in a storage tank and was piped into the brining tank for dilution to the salinity desired. In operation, the tank was replenished when the level lowered due to loss by adherence to fillets passing through.

CONDITION OF BRINE AFTER VARIOUS TIME INTERVALS

Samples of brine were withdrawn by sterile pipette from the tank every half hour during a run. A run consisted of an interval of two hours. Generally, four runs were made during each operating day. The poundage of fish fillets put through in a given run varied from 1,500 to 4,000. Variations in poundage were due to erratic supply of fillets. The brine level of the tank, salinity, cleanliness of the brine, and the rate that fillets pass through varied to the extent that sampling at the intervals stated, could well be expected to show variations in bacterial counts. It was felt, however, that a trend in population could be demonstrated if a sufficient number of runs were sampled.

Ten ml. of the sample were diluted to suitable dilutions. Nutrient agar plates were poured in duplicate and were incubated at 37° C. for 48 hours. Salinity, temperature, and pH readings were taken at each sampling. A Beckman pH meter was used for determinations of the hydrogen-ion concentration, and a hydrometer graduated in percent saturation was used for determining the salinity.

Findings

The bacterial population, salinity, temperature, and pH of the brine for seven runs are shown in Table 1. These data show that there is a rapid rise in the bac-

Table 1 - Bacterial Population, Salinity, Temperature, and H-ion Concentration of Brine After Various Time Intervals

Time of sampling (hours)	0	0.5	1.0	1.5	2.0
Run No. 1 - mixed skinned and unskinned haddock, approx. 4,000 lbs.					
Bacteria per ml. brine	54,000	920,000	960,000	1,110,000	834,000
Salinity (% sat.)	47	48	55	52	65
Temp. °C.	11	11	11	10	10
pH	6.22	6.18	6.10	6.15	6.10
Run No. 2 - mixed skinned and unskinned haddock, approx. 3,000 lbs.					
Bacteria per ml. brine	34,000	268,000	760,000	600,000	360,000
Salinity (% sat.)	38	37	35	39	37
Temp. °C.	11	11	11	10	11
pH	6.25	6.20	6.26	6.19	6.20
Run No. 3 - unskinned haddock, approx. 2,800 lbs. fish fillets - not full run					
Bacteria per ml. brine	27,800	117,000	518,000	915,000	
Salinity (% sat.)	40	39	36	48	
Temp. °C.	13	13	13	13	
pH	5.68	6.22	6.24	6.19	
Run No. 4 - unskinned haddock, approx. 3,000 lbs. fish fillets - not full run					
Bacteria per ml. brine	27,800	319,000	500,000	813,000	
Salinity (% sat.)	47	58	50	55	
Temp. °C.	12	11	11	11	
pH	6.11	6.00	6.20	6.16	
Run No. 5 - unskinned haddock, approx. 3,000 lbs. fish fillets					
Bacteria per ml. brine	10,800	350,000	790,000	910,000	1,070,000
Salinity (% sat.)	48	50	50	58	56
Temp. °C.	12	10	10	10	10
pH	6.02	6.16	6.27	6.16	6.15
Run No. 6 - mixed skinned and unskinned haddock, approx. 1,500 lbs.					
Bacteria per ml. brine	8,800	545,000	340,000	575,000	
Salinity (% sat.)	95	94	90	89	
Temp. °C.	13	13	12	12	
pH	5.66	5.77	5.90	5.92	
Run No. 7 - unskinned haddock, approx. 3,000 lbs.					
Bacteria per ml. brine	12,000	118,000	203,000	1,270,000	600,000
Salinity (% sat.)	95	91	84	80	79
Temp. °C.	14	12	11	11	11
pH	5.56	5.90	5.97	6.02	6.09

terial population of the brine as the run progresses, with a tendency for the count to level off and drop slightly, in some cases, toward the end of a two-hour run.

The brine strength apparently has no real effect on the bacterial population. The temperature remains essentially constant due probably to the chilled fish from the carts moving steadily along the production line. The pH rises slightly as more fish pass through the tank, but is effected also by the strength of brine, being lower, in general, when the brine is more concentrated. The probable cause of the rapid increase in the bacterial count is associated with the washing action of the brine at the initial stages of the run. This activity is reduced as more fish pass through the tank. Variations develop and are promoted by the erratic supply and flow of fillets. Other variables are brine level, salt concentration, age of the fish, and mixed fish in the same run. More consistent trends in the bacterial counts could hardly be expected without more exacting control; however, the results of the seven runs indicate that some means should be employed to keep the bacterial count down in the brining tanks.

CONDITION OF FILLETS BEFORE AND AFTER BRINING

Gutted and headed fish were removed from the line and filleted by hand. Skinned or unskinned fillets were cut and equal portions of approximately 50 grams were taken from the head end of each fillet, one being retained and the other being passed through the brining tank as in commercial practice. It was assumed that the two pieces of fillets from the same fish and the same part of the fish would have similar initial bacterial populations. The brined and unbrined samples were placed in a sterile Waring blendor containing 200 ml. of water to be slurried for sampling. Ten ml. of the slurry were removed for subsequent dilution and plating. A sample of the brine was taken at the same time as the fillets were put through the tank.

Findings

The results of the sampling (Table 2) indicate that the brine in the initial stages of the run is effective in producing a slight washing action to the fillets

Table 2 - Bacterial Counts on Fish Fillets Before and After Brining

Sample No.	Properties of Brine	Fillet Before Brining Bacteria per gm.	Fillet After Brining Bacteria per gm.	Brine Bacteria per ml.	Remarks
1	Temp. 12° C. Salinity 43%	3,640,000	1,840,000	-	Skinned cod; 800 lbs. after 30 minutes
2	Temp. 13° C. Salinity 44%	960,000	940,000	670,000	Unskinned haddock; 1,000 lbs. after 30 minutes
3	Temp. 12° C. Salinity 59% pH 6.05	310,000	460,000	780,000	Unskinned haddock; 2,000 lbs. after 1½ hours
4	Temp. 12° C. Salinity 51% pH 6.00	294,000	357,000	790,000	Unskinned haddock; 4,000 lbs. after 2 hours
5	Temp. 11° C. Salinity 51%	475,000	900,000	-	Skinned cod; 4,000 lbs. after 2 hours
6	Temp. 12° C. Salinity 54%	410,000	600,000	-	Skinned haddock; 6,000 lbs. after 2 hours

which decreases the bacterial count. The data indicate that after the brine is used for a period of approximately one hour the destructive effect on the bacterial population is lost. The data definitely show that the brining tank becomes a source of contamination as the run progresses toward completion.

EFFECT OF CHLORINE ON THE BACTERIAL POPULATION OF BRINE AND FISH FILLETS

To test the efficiency of chlorine on the bacterial population of the brine, chlorine in the form of calcium hypochlorite was added to the brine intermittently. It was rather difficult to maintain a given concentration of chlorine by manual means because of the rapid absorption of chlorine by the fish fillets. The results of this test are shown in Table 3. Bacterial counts on fillets after passing through chlorinated brine are shown in Table 4.

Table 3 - Bacterial Population of the Brine Tank with Chlorine Added

Time of Sampling (hours)	0	0.5	1.0	1.5
Run No. 1 - unskinned haddock, approx. 2,000 lbs. - not full run				
Bacteria per ml. brine	6,000	640,000	390,000	50,000
Chlorine (ppm.)	3	0.75 (added)	0.5 (added)	1.0 (added)
Salinity	41	39	39	50
Temp. °C.	11.5	11	11	12
pH	5.9	6.15	6.20	6.20

Table 4 - Bacterial Population of Fillets Passing Through Chlorinated Brine

Sample No.	Properties of Brine	Fillet Before Brining Bacteria per gm.	Fillet After Brining Bacteria per gm.	Brine Bacteria per ml.
1	4 ppm. chln., sal. 45% temp. 12° C., pH 6.5	125,000	33,000	0
Remarks - unskinned haddock, no fish through brine at initial part of run - chlorine gone at check with 500 lbs. of fillet through.				
End of run	0 ppm. chln., sal. 70% temp. 12° C., pH 6.0	100,000	200,000	790,000
Remarks - unskinned haddock, 2,000 lbs. fish through at the end of run (2 hrs.) slow operations with miscellaneous haddock and cod completing the run.				
2	6 ppm. chln., sal. 43% temp. 13° C., pH 6.3	365,000	50,000	0
Remarks - skinned haddock, no fish through brine, initial part - chln. at 2 ppm. in matter of minutes.				

Findings

The addition of chlorine to the brining tank keeps down the count in the brine; however, the chlorine demand is such that a residual cannot be maintained by manual application for more than a few minutes. It would be erroneous to assume that a single application of a reasonable concentration of chlorine, one which would not impair the flavor of the fillets, would last and be effective for a whole brining period. There are definite indications that the bacterial count of the fillets can be reduced markedly by the proper use of chlorine in the brining tanks, giving the assurance of a more wholesome product during storage and shipment.

CONCLUSIONS AND RECOMMENDATIONS

The limited data indicate that brining tanks of fish filleting lines can be a potential source of contamination to fish fillets. It is recommended, therefore, that consideration be given to the improvement of the brining technique through the proper addition of chlorine and such means as may be economical for removing the debris from the tank while in operation. The chlorine concentration should be automatically controlled to maintain an effective residual. Also, the salt concentration should be automatically controlled, primarily for the purpose of maintaining a uniform appearance and taste of the filleted fish product. In conjunction with this, some means of insuring a more uniform brining of all fillets in the tank should be incorporated in the brining system for better quality control.

Some means of keeping the brine clean over a given period through the installation of a filter device with a recirculator should be considered. A combination of these improvements would produce a fillet relatively low in bacterial count at any time in the run, a clean fillet with no slime or adhering scales, and a fillet with a uniform brine film.

LITERATURE CITED

LEMON, J. M.

1947. Fish refrigeration. Fishery Leaflet 214, U. S. Department of the Interior, Fish and Wildlife Service.

SPARTALES, J. J.

1938. The evaluation of a chlorine spray device in plant sanitation, B.S. Thesis, MIT.

STANSBY, M. E., and HARRISON, R. W.

1942. Preliminary investigation of methods for freezing and storing fillets of some Pacific Northwest fish. Special Scientific Report 15, U. S. Department of the Interior, Fish and Wildlife Service.

VUCASSOVICH, M. P.

1947. Flume system aids brining and siruping operations. Food Industries, Vol. 19, No. 1, pp. 88-90.

ADULTERATION AND MISBRANDING

A food is adulterated if it bears or contains any poisonous or deleterious substance. It is adulterated if it consists in whole or in part of a filthy, putrid, or decomposed substance, or is otherwise unfit for food, or has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth or rendered injurious to health. It is adulterated if it is in whole or in part the product of a diseased animal. A food is misbranded if its labeling is false or misleading in any particular, or if it is offered for sale under the name of another food, or if its label fails to bear its common or usual name if it has any. The above are not all of the adulteration and misbranding provisions applicable to fishery products, of course, but are those which give most concern at times.

--Statement by L. D. Elliott, Assistant Commissioner of Food and Drugs, Food and Drug Administration, Federal Security Agency, before the National Resources Economic Subcommittee of the Senate Committee on Public Lands, July 2, 1947.