IMPROVEMENTS IN PROCESS OF SALTING RIVER HERRING, ESPECIALLY ADAPTED TO WARM CLIMATES.[1]

By HARDEN F. TAYLOR, *Technologist, U. S. Bureau of Fisheries.*

Contribution from the Fishery Products Laboratory, Washington, D. C.

INTRODUCTION.

In the warmer parts of the United States it has generally proved to be difficult, if not impossible, to preserve certain kinds of fish by salting, though some kinds appear to be more difficult of preservation than others. The reason for failure was believed to be that at warm temperatures the fish spoils before the salt penetrates to the innermost parts; this belief was verified experimentally in an investigation[2] in which several improvements in the process of salting alewives or river herring were evolved. No doubt these improvements are applicable also to other kinds of fish. As will be seen below, none of them are really new, but well known procedures were studied chemically and variations which gave best results were followed in every case, so that the process is very much more successful under adverse conditions, and the final product is superior in quality.

While the procedure herein described has been quite successful in a small way, it will be understood by all cautious persons that no unusual methods should be applied on a large scale until their practicability has been thoroughly established by commercial application. In Florida some 80,000 river herring, or alewives, were salted under the supervision of this Bureau in the 1920 season. These were marketed at a good price, and no complaints were lodged with the producers, so far as known. It therefore seems proper to make available in practicable form the details of the process employed for those who care to try it.

As stated above, the difficulty in salting fish in warm climates seemed to be due to slow penetration of salt and rapid decomposition of the fish. Obviously, then, any procedure that hastens penetration of salt and retards decomposition of fish should improve the prospects of success. A number of simple and practicable ways of doing both of these things were found. For example, it was found that calcium, or lime, and magnesium, the common impurities in salts used commercially, retard penetration altogether out of proportion to the quantities present. A salt consisting of 4.7 parts of magnesium

[1] Appendix II to the Report of the U. S. Commissioner of Fisheries for 1921. B. F. Doc. No. 908.

[2] For original chemical and scientific data on which this paper is based, see "Some Considerations Concerning the Salting of Fish," by Donald K. Tressler, B. F. Doc. No. 884, Appendix V, Report, U. S. Commissioner of Fisheries for 1919.

chloride and 95.3 parts of pure salt required five days to penetrate fish to the extent that pure salt did in three days; and the same salt required nine days to penetrate as far as pure salt did in four and one-half days. It was found that salt applied dry to fish penetrated fish as deeply in five days as saturated brine did in eight days. It was found that blood spoiled at a lower temperature than fish flesh, and that fish containing blood, roe, and milt spoiled at about 65° F., while thoroughly cleaned fish could be salted successfully at 90° or even 100° F. It remained, therefore, only to take advantage of these principles and to apply certain facts already known from other sources to hasten penetration of salt and retard decomposition of fish until they are preserved.

PRINCIPLES OF IMPROVED PROCESS.

The principles will now be taken up and discussed in such a way that by following in detail the method outlined it is believed any person can carry them successfully into practice. The principles are:

1. Careful handling of fish before salting.
2. Thorough cleaning, especially removal of all blood.
3. Use of salt of a high degree of purity.
4. Application of salt in the dry condition.

To these should be added—if the fish are to be stored for any considerable length of time—storage of fish in brine. (There is considerable doubt of the feasibility of storing salt fish in very warm climates; until this subject is investigated it seems advisable to hold only in cool storage.)

These principles are known, at least in part, to many experienced salters of fish, yet the combination of them all is rarely or never followed. The great difference that is made in the quality of salt fish by following them will be readily observed upon comparing the product with that of ordinary processes.

1. Careful handling of fish before salting.—Two precautions are particularly important under this head, namely, to avoid bruises and to avoid warmth. Bruises promote decomposition of fish in the same way that they cause fruits to rot. Therefore, fish should not be forked, walked on, squeezed when taken from nets, nor packed deep in boats, boxes, or barrels, and care should be exercised to see that they are not crushed or bruised by large chunks of ice. Warmth, as every fisherman knows, hastens decomposition. It is best to put the fish in finely crushed ice immediately after capture, but if not so treated they should be kept as cool as possible and should be salted with the least possible delay. It is well to remember that fish are of about the same temperature as that of the water from which they come, and therefore fish taken from warm water should be handled more expeditiously than those from cold water. Fish should be shielded from direct sunlight and should not be allowed to dry, as the skin shrinks and loses its luster if dried.

2. Thorough cleaning, especially removal of all blood.—It has been found in the case of river herring that blood spoils at a much lower temperature than flesh. These fish can be salted at from 90° to 100° F. or higher if the blood is all removed, while those containing

blood will sour if salted at 65° F. In cool climates the blood may be left in the fish if desired, as it imparts a distinct flavor, for example, in the Scotch method of curing herring. But in warm climates, where conditions are unfavorable at best, there is no choice but to remove every trace of blood as well as all entrails and roe and the head. To do this it is necessary to behead the fish, take out entrails, scrape the kidney out (the bloody strip lying under the backbone), and wash the fish thoroughly. (A 20-penny wire nail, the head of which has been sharpened with a file, makes a convenient instrument for scraping out the kidney.) Large fish may be split through the back and laid open. The washing should preferably be done by rousing the fish in brine of about the strength of sea water, but it may be done in cold fresh water. In the case of alewives or river herring, the washing operation should also serve to remove scales by vigorous rousing. It may seem that if the blood spoils at 65° F. the meat of the fish would not necessarily be ruined. But the taint of spoiled blood is sufficient to make the entire fish unfit for food. It is also probable that the presence of blood may initiate a kind of decomposition of the flesh.

3. USE OF SALT OF A HIGH DEGREE OF PURITY.—This is the most important factor in salting fish in warm climates; yet some people are inclined to question the truth of this statement. Fishermen generally have no first-hand way of knowing whether or not any particular lot of salt is pure, as neither the looks of salt nor the claims of advertising matter are always reliable indications of purity. By purity is meant not cleanness but the scarcity of foreign substance in the salt. Salt may be highly impure yet perfectly white and very fine and clean, for the two most objectionable impurities, lime and magnesium salts, are white, like salt. On the other hand, salt may be dirty or colored, and yet if lime and magnesium salts are absent may penetrate and preserve the fish.

It is therefore necessary to have a salt of a very high degree of purity; that is, with less than 1 per cent total impurity. There are grades of salt on the market containing a total of less than one-tenth of 1 per cent impurity.[1] These salts are especially suitable for salting fish by this method. Chemical analysis is the only reliable guide to purity; most reliable dealers are able to give the correct analyses of their brands of salt, and these figures should be required before purchase. The figures for sodium chloride (pure salt) should be 99 per cent or over—the higher the better, 99.96 per cent sometimes appearing. The figures for calcium (lime) and magnesium salts should be as low as possible. It makes little difference whether they are sulphates or chlorides, any salt in which calcium and magnesium taken together are more than 1 per cent should be looked upon with suspicion for salting fish in warm climates.

The presence of moisture does not cause the salt to be unsuitable. If moisture is present, as it usually is, allowance should be made for it; pure salt (sodium chloride) and moisture added together should

[1] Names of manufacturers of satisfactory brands of salt will be supplied on application to this Bureau; also if analysis of a salt is furnished, the Bureau will, upon request, give opinion as to its suitability for curing fish.

exceed 99 per cent. The following example will illustrate the point. A chemical analysis of some lot of salt is, let us say:

	Per cent.
Sodium chloride	97.50
Moisture	2.00
Magnesium chloride	.25
Calcium sulphate	.25
Total	100.00

This analysis shows only 97.5 per cent pure salt—which might not appear suitable for fish. But allowance must be made for the harmless moisture present. Strictly calculated, after this allowance is made, there is found to be 99.49 per cent pure salt; practically the same result (though not absolutely correct), 99.50 per cent is the sum of pure salt and moisture. The sample is therefore very pure and suitable for salting fish.

Calcium and magnesium in salt, even in small quantities, greatly retard penetration, so much so that in warm weather the fish may spoil before the salt strikes through. But in cold weather in northern climates salt containing considerable quantities of these substances may be used successfully. It will be noted by those who use highly purified salt that the fish do not become white and firm as they do with ordinary Turks Island, Trapani, or other crude salt. The lime and magnesia have a hardening effect on fish, and they whiten the flesh by coagulating it, as heat whitens the white of egg. Nevertheless, the somewhat yellowish, soft fish, produced in pure salt is equally as well preserved as the hard fish in crude salt, is milder and richer in flavor, and soaks out more quickly. This may be somewhat difficult to introduce in a market that has been accustomed to a hard, white fish, but the consuming public should not be long in discerning the superiority once the purer fish is distributed.

It may be objected that pure salt is too expensive. The crude salt may be, let us say, $10 per ton and pure salt $25, a difference of $15 per ton more for the pure grade. Fifteen dollars per ton is three-fourths of a cent per pound; about 35 pounds of salt will suffice for 100 pounds of fish. The difference in cost for salt is therefore about 27 cents per 100 pounds of fish, or one-fourth of a cent per pound on the basis of the above assumption. The loss of a few barrels of fish (including the labor that was put upon them) will cover the cost of a large pile of pure salt. In very warm climates, in salting river herring, pure salt is necessary to safety.

4. Application of salt in the dry condition.—There is very extensive business in both dry salting and brine salting or pickling fish. In the case being considered, where the greatest speed of penetration is necessary, the dry salt must be used, for, applied in this way, it penetrates much faster than brine. Again, the fisherman fortunately located in a cool country may follow his discretion, but the fisherman who works under the handicap of a warm climate will find it necessary to use the salt dry.

About 35 pounds of salt to each 100 pounds of fish is sufficient, if well distributed. The fish should be rolled in the salt (which should be fine grained), the belly cavities filled, and the fish packed backs down in tubs so as to hold the salt until it dissolves. These tubs may be made by sawing barrels in two in the middle. A weight should be

placed on the fish to keep them from floating, but not sufficient to press or crush the fish. If barrels are used they should not be filled at first, as the pressure will be too great on the fish at the bottom, but after the fish are struck through barrels may be packed full.

The reason for using dry salt is not difficult to see. It is the brine or salt immediately in contact with the fish that acts on the fish. If brine is used, the water coming from the fish dilutes it and it rapidly becomes less effective unless the fish are continuously stirred; but if dry salt is used, the water coming out of the fish immediately becomes saturated with salt, so that the brine in contact with the fish is saturated at all times.

If the brine is warm, the fish may be struck through in less than 24 hours, but ample time should be allowed. It appears that the warmer the brine, the faster it penetrates; and also the faster the fish spoils; there should be therefore some temperature which would give the most rapid penetration without excessive decomposition, but this temperature has not been determined. One soon learns to tell by the appearance of fish after it is broken through the backbone whether or not it is struck through.

SHIPPING OR STORAGE OF FISH IN BRINE.—If for immediate market, the fish may be taken from the brine and shipped at once. This involves draining off the brine, applying some more dry salt, packing the fish in sugar barrels or other containers, and shipping. In this condition the herring are excellent, but will not keep long, as the fat will rust and become rancid. In case the fish are to be held for a period of weeks or months, it will be necessary to keep them under brine at all times for the purpose of excluding air which causes the fat to rust. They should be allowed to remain in their original brine, strong, tight barrels being used. The barrels should be quite full of fish, and there should be a slight excess of undissolved salt. The barrel should be tightly headed, turned on its side, and nearly filled with brine through the bunghole, leaving slight space for expansion, and then bunged up. It should be stenciled or otherwise marked to show the nature and net weight of the contents. In very warm climates there is need for investigation of storage conditions under which salt fish can be kept successfully; until the subject is investigated, it is recommended that if fish are to be kept for any considerable time, they be placed in cool storage.

SUMMARY.—If the method is followed as herein described, river herring (and possibly other fishes) may be salted under surprisingly unfavorable conditions of temperature; the cured fish will be sweet and mild; they will soak out readily, and be free from the acrid salty taste characteristic of fish that have been cured in salt containing calcium and magnesium. They will be softer and less white or chalky in appearance than fish cured in crude salt, but these differences should be regarded as marks of superior quality.

Numerous recipes for cooking salt and smoked fish will be found in Economic Circular No. 29, "Why and How to Use Salt and Smoked Fish," published by the Bureau of Fisheries, and sent free on application.

○