APPLIED SCIENTIFIC RESEARCH CORPORATION OF THAILAND

RESEARCH PROGRAMME NO. 23

THE USE OF ANTIBIOTICS FOR FOOD PRESERVATION

RESEARCH PROJECT NO. 23/1

THE USE OF ANTIBIOTICS

FOR THE PRESERVATION OF FISH, SHELLFISH, AND FISHERY PRODUCTS

REPORT NO. 1

BOILED FISH. I.

STUDIES OF THE TRADITIONAL METHOD OF PRESERVATION

BY

MALEE SUNDHAGUL

MICROBIOLOGY UNIT, INDUSTRIAL CHEMISTRY GROUP

TECHNOLOGICAL RESEARCH INSTITUTE

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by Malee Sundhagul*

SUMMARY

The traditional method of boiling fish in strong brine as a means of short-time preservation has been studied. Bacterial analyses were made at each major step during processing to determine the total bacterial changes due to processing procedures. It was found that salt acted as a bactericidal agent, killing more than half of the original bacterial load of the fish. Boiling added to the inhibitory effect by destroying heat-labile micro-organisms, and also enzymes.

The keeping quality of the boiled fish produced under normal practical conditions was found to be unsatisfactory due to unsanitary condition of the plant and improper handling of the fish during processing. The finished product can be kept for only two days at ordinary temperatures after which time it becomes unfit for consumption. The keeping time was shown to be dependent mainly on the salt and moisture contents, and the bacterial number of the finished product.

It is felt that improvement of the keeping quality could be made by improving the sanitation of the plant and better handling of the fish.

INTRODUCTION

Thailand is one of the leading fishing nations of South-east Asia. Modernization and mechanization of the fishing fleets in recent years has resulted in rapid increases in fish production (Bergstrom 1965). Among the many types of fishes caught, the chub mackerel, called 'plathu' (Rastrelliger sp.), is considered the most popular and most economical. In 1965, the total fish catch was over half a million tons and the chub

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mackerel comprised more than ten per cent of the total production (Department of Fisheries 1966).

Fish is probably the most available and cheapest source of high quality protein in Thailand. The prices (Division of Agricultural Economics 1966) and protein contents (U.S. Department of Agriculture 1959) of certain common animal protein foods are shown in Table 1.

TABLE 1

WHOLESALE PRICES AND PROTEIN CONTENT OF CERTAIN ANIMAL PROTEIN FOODS

Type of food	Price in baht per kg	Per cent protein
Beef	7.27	19.5
Prok	8.95	16.4
Chicken	10.94	20.2
Fish	3.90 (*Rastrelliger* sp.)	18.2

It can be seen that fish costs only about half the price of beef or pork and nearly a third of the price of poultry. Therefore, increasing fish consumption affords an economic way of ensuring a more nutritionally balanced diet with respect to protein for the people.

Fresh fish, unfortunately, is relatively highly perishable and, consequently, has only short keeping time at ordinary temperatures. As a result, distribution is limited to big cities and areas closed to the fishing ports. The exceptional perishability of fresh fish led to the evolution of traditional curing techniques such as salting, smoking, or boiling, and of modern techniques of canning and freezing, to preserve them from spoilage. These traditional processes are important nutritionally, quite independently of the food value of the products, first, because they permit the preservation of fish that could not otherwise be utilized and distributed in an edible state, and, secondly, because they increase the varieties in which fish can be presented.

In Thailand, approximately fifty per cent of the total catch is

consumed fresh and the rest processed and preserved in various ways. For the chub mackerel, the two most common methods of preservation are salting, and boiling in brine. Table 2 shows the amount of the chub mackerel consumed fresh and the amount preserved.(Department of Fisheries 1966). Salting is a long-time preservation technique, while boiling in brine is considered a short-time preservation method. Boiled mackerel has a very unique taste and is very palatable. It is one of the most important and traditional fish products relished by the Thai people.

TABLE 2

AMOUNT OF CHUB MACKEREL
CONSUMED FRESH AND AMOUNT PRESERVED

Total catch (tons)	Total mackerel (tons)	Consumed fresh (tons)	Preserved (tons)
494,196	52,524	37,091	15,433

In this paper, the author attempts to present an outline of the traditional method of boiling the fish in strong brine, and results of the research on the requirement for the manufacture of high quality boiled fish.

MATERIALS AND METHODS

Fresh and boiled chub mackerels were obtained from the Fish Marketing Organization and from local processors respectively. Unrefined solar salt was purchased from the local market.

Storage. The boiled fishes were placed, unwrapped, on bamboo trays which were stacked together one on top of the other as shown in Fig. 1. The top tray was covered with a similar type of tray but placed upside down. The trays were stored in a screened cabinet at room temperature ($30^{\circ}C$).

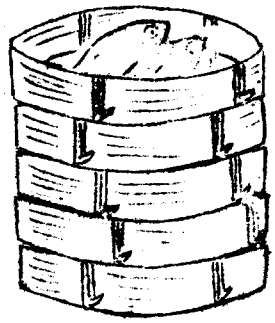

Fig. 1. Stack of bamboo trays containing boiled fishes.

Bacterial counts. Bacterial counts were made by the pour plate method using Difco tryptone glucose extract agar (Difco Laboratories Inc. 1958). The plates were incubated at ambient temperatures (27°-29°C) for 48 hours. The dilution samples were prepared by homogenizing the whole fish in sterile distilled water (1:3 w/v) in a Waring blender. Four ml of fish homogenate was then added to 96 ml of sterile distilled water to obtain 10^{-2} dilution.

Assessment of spoilage. The state of spoilage was evaluated organoleptically. The arbitrary criteria used for judging were the colour of the skin, odour, and the texture of the fish. Fishes giving sour or rancid smell or showing any sign of microbial growth were regarded as spoiled.

The moisture content was determined on the basis of weight loss after drying the ground sample at 95°C overnight (Pierce and Haenisch 1956). The salt concentration was determined by the Mohr method (Pierce and Haenisch 1956).

Processing Method

Fishes, fresh or thawed, were de-gilled and the entrails were removed through the mouth. They were then washed in slowly running water to remove dirt and blood before mixing them with a small amount of unrefined solar salt. Salted fishes were then immersed in saturated brine for approximately 30 minutes. Three to five fishes so treated were arranged on a bamboo tray. Several of these trays were put into a

large bamboo basket for cooking in strong brine of 25 to 30 per cent. As soon as the boiling began, more brine was added to stop the boiling and also to allow the foam and dirt to overflow. The product was considered done after the second boiling. The total cooking time was approximately 10 minutes. The cooking process was repeated in case a product with higher salt concentration and less moisture was required. The flow sheet of the processing of boiled fish is shown in Fig. 2.

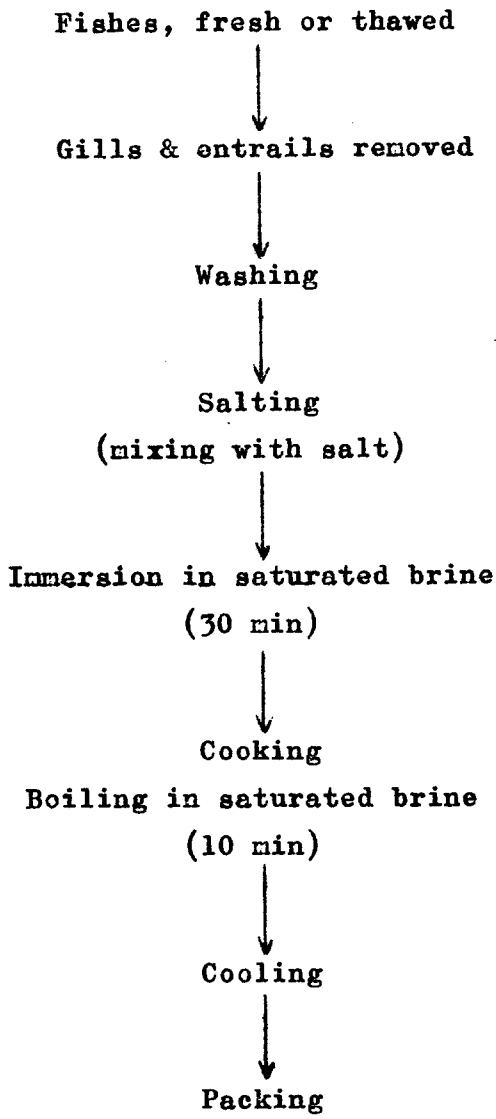

Fig. 2. Flow sheet of the processing of boiled fish.

RESULTS AND DISCUSSIONS

As a result of salting and cooking in strong brine certain physical and chemical changes occurred. The penetration of salt into the fish flesh caused a contraction of the muscle tissue, resulting in shrinkage. The structural network of the muscle tissue changes and becomes more durable and elastic (Bergstrom 1965). Cooking by boiling denatured and coagulated the protein. As a consequence, the fish flesh became stiffer and denser.

The salting process also resulted in the penetration of the salt into the fish tissue while some water was removed. Usually the boiled fish which was cooked only once in the brine contained 4 to 6 per cent of salt. The moisture of the cooked fish was approximately 66 per cent as compared to 72 per cent found in fresh fish. Boiling in the brine for the second time resulted in higher salt concentration of 7 to 9 per cent and in a further reduction of moisture content to 60 per cent. Table 3 shows certain chemical changes of boiled fish.

TABLE 3

CERTAIN CHEMICAL CHANGES OF BOILED FISH

	Fresh fish	Once-boiled fish	Twice-boiled fish
Protein %*	18.2	21.8	26.8
Moisture %	72	66	60
Salt (wet wt.) %	-	4-6	7-9

Salting technique as it is generally practiced is the mixed salting method. The fish is salted simultaneously with salt and with brine. The salt on the surface of the fish prevents the brine from becoming diluted. As it dissolves in the water that comes out of the fish, an additional quantity of salt brine forms. Therefore, the salt brine remains saturated, and the process of salting begins immediately

* Unpublished data, Fish Technology Laboratories, Department of Fisheries.

after the fish comes into contact with the brine and the salt, without sharp dehydration of the outer layers of fish meat (Bergstrom 1965).

It was found that, for the chub mackerel, the moisture change was very slight, if any, while the salt content increased to 3.3 per cent at the end of 30-minute salting period. The moisture and salt contents of the chub mackerel before and after processing are shown in Table 4.

TABLE 4

MOISTURE AND SALT CONTENTS OF CHUB MACKEREL BEFORE AND AFTER PROCESSING

Processing step	Moisture %	Salt %
Before salting	72	-
After salting	74	3.3
After cooking	65	3.7

Keeping Quality

As compared to fresh fish, one of the characteristic properties of boiled fish is its better keeping quality. In general, it can be kept in edible condition for 2 days at room temperature (30°C). Increasing the salt concentration and reducing the moisture content of the boiled fish resulted in longer shelf-life. This can be accomplished by reboiling the fish in the brine. Table 5 shows the keeping time of the once-boiled and twice-boiled fishes.

TABLE 5

KEEPING TIME OF ONCE-BOILED AND TWICE-BOILED FISH

Type of product	Keeping time (days)
Fresh fish	less than 1
Once-boiled fish	22
Twice-boiled fish	6

The increase in shelf-life of the boiled fish as compared to fresh fish was attributed to the action of salt and of boiling. Common salt, it is known, can slow down or prevent bacterial spoilage of perishable foods. Cooking the fish by boiling in brine further reduces the number of bacteria in and on the fish by destroying heat-labile micro-organisms. In addition, the enzymes are also destroyed by the heat, thus preventing autolysis which is one of the main causes of spoilage. Table 6 shows the effect of salting and boiling on the number of bacteria.

TABLE 6

EFFECT OF SALTING AND BOILING ON THE NUMBER OF BACTERIA

Type of treatment	No. of bacteria per g of fish
None	1.3×10^6
Salting	8.0×10^4
Boiling	4.2×10^2

Bacterial Changes

Bacterial analyses were made at each major step during processing to determine the total bacterial changes due to the processing procedures such as dressing, salting, and boiling. Examination of production-line samples will pinpoint processing practices that tend to cause large increases of undesirable micro-organisms, especially in view of the poor sanitary conditions usually found in boiled fish processing plants. The changes of total bacterial counts during processing is shown in Table 7.

TABLE 7

CHANGES OF TOTAL BACTERIAL COUNTS DURING PROCESSING

Step during processing	No. of bacteria per g of fish
Fresh fish after delivery to plant	3.3×10^5
Fresh fish after removal of gills and intestines	6.9×10^5
Dressed fresh fish after washing	4.1×10^5
Dressed fresh fish after salting	1.3×10^5
Salted fish before cooking (piled up on the floor)	3.6×10^5
Fish, after cooking in brine	2.3×10^3

In general, it takes approximately from 10 to 15 hours for transportation of the fresh fish from the landing ports to the processing plants situated in Bangkok. This fact accounted for the high count before any processing has been started. Large numbers of bacteria are located in the gills and the intestines. However, removal of gills and intestines did not reduced the number of bacteria to any great extent. This was due to the entrails which had been removed not being properly disposed of, and, therefore, served as a source of recontamination of the fish. Washing also reduced only slightly the bacterial count. This was because the water used for washing was itself highly contaminated, as the result of repeated washings. Salting reduced approximately one third of the total bacterial number at the end of 30-minute salting period. Unfortunately, the salted fish were placed on the floor after they were taken out of the salting vats. This practice brought the number of bacteria back to almost the same amount as they were before salting. The greatest reduction of the total count was obtained by boiling the fish in brine, resulting in the finished product containing only about 2,000 bacteria per gramme of fish.

CONCLUSIONS

Rapid increase in fish production in recent years demands a closer look into the problem of fish food preservation. Boiling fish in brine, a traditional method for short-time preservation, has been studied in order to find ways of improvement of the keeping quality of the products.

The effectiveness of the boiling technique was attributable to the action of salt and of heating by boiling which resulted in the reduction of bacterial numbers of the product and the destruction of fish enzymes, both of which were known as the main causes of spoilage. The conditions of all the boiled fish processing plants visited, in general, were found to be unsanitary resulting in the relatively high contaminated product.

The keeping quality of the product produced under normal practical conditions was, therefore, unsatisfactorily. The keeping time of two days was not long enough for effective distribution to most inland markets of the product in an edible state. It is felt that improvement of the keeping quality and thereby prolonging the shelf-life could be made by improving the sanitary condition of the plant, by better handling of the fish during any after processing, and also possibly by the use of certain preservatives.

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