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An Investigation into the Microbiological Quality of Fish in Guatemala and Costa Rica

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GENERAL INTRODUCTION

The following two reports are intended to be preliminary studies indicating how fish are treated as they are caught and sold in the Central America region. Guatemala and Costa Rica were chosen as good places to begin since they span the area and represent various geographical and cultural differences.

An important group of fishermen in Central America and around the world still "hunt" for fish in the same fashion as their forefathers did. In this sense, they are classed as artisan fishermen as opposed to their industrial brothers who fish with highly mechanized vessels and fishing systems. Although they represent a small percentage of the population of a country, their mission is of vital importance. They and their families supply much needed animal protein in the form of fin fish and shell fish which may be the decisive factor between malnutrition and health for many people. In general, their catches are low, and the handling, processing, marketing, and distribution systems are poor. By improving these systems, the life of the artisan fisherman could improve with more fish reaching the tables of hungry people.

As this was a beginning study of conditions in the artisan fishery, a broad survey was envisaged rather than one in greater depth. Two reports resulted, each examining different aspects of fish handling in the two countries. An initial attempt was made to assess the condition of fish from the point of capture to the point of consumption. In Costa Rica, fish were sampled first as they were caught, again before being taken to market in the capital city, and finally when displayed for sale. Samples were tested microbiologically, and observations were made on sanitary conditions in the distribution process for fish in Costa Rica. In Guatemala, fresh and processed fish in various markets in the capital city were examined microbiologically and observations were made relative to sanitary conditions there. While by no means exhaustive, these reports serve to show that improved handling would be beneficial in the Central American region.

By involving CITA in Costa Rica and ICAITI in Guatemala, an interest was generated on their part to continue working in this area of improved utilization of the artisan catch. This work paves the way for further studies in the area to include recommendations for fish handling and distribution, methods of improving the existing fish processing methods, and development of food technology in the region related to fish utilization.

GENERAL RECOMMENDATIONS

From these two reports, it can be seen that fish handling and sanitary conditions in the artisan fisheries of Costa Rica and Guatemala could be improved. This is true throughout the distribution process from conditions on the boat at capture, to the holding areas on shore, to the trucks used in transport and to fish storage and display at the fish market. While there are anomalies in results that can only partially be attributed to the use of different methods (for example, the number of coliforms in fresh fish samples), general conclusions can be made.

Potable water is needed in more abundance so that washing may be done more often and more thoroughly. Boats, containers, utensils and all surfaces coming in contact with ice or fish should be washed with mild detergents and rinsed well. Ice should be of good quality and should not be reused. Pressure on the fish is a major cause of deterioration. This results from piling the fish too high and using ice in pieces so large they bruise or pierce the fish during storage and transport. Flake ice in stacking boxes would help solve this problem. Improved handling and sanitary practices can benefit the fisherman and the distributor, the processor and the consumer. Thus fisherman and distributor would have fewer losses due to spoilage. The processor would have fish of high quality needed to ensure good results in his products. The consumer would have fish more available to use at lower cost in appetizing meals with less risk of food poisoning.

One problem not easily tackled is the lack of enforcement of regulations that do exist regarding the handling and distribution of fish and other perishable commodities. Adequate facilities may be provided but no corrective action is taken by authorities when these facilities are misused. Standards of hygiene may be enacted but until enough importance is accorded these standards, little will have been accomplished.

Improved handling might come about if the consciousness of the general population is raised through an intensive campaign by government and universities on radio and television about fish and its value. It would be helpful to have a survey of current practices in fish handling and consumer use so that the correct emphasis can be made in later work. An appropriate technology for all areas of the fishery -- capture, processing and distribution -- would thus serve to effectively improve fish entering the market.

REPORTS

Costa Rica -- An Investigation into Fish Quality of the Artisan Catch of Costa Rica from Capture to Point of Sale

Abstract

Samples of fish caught by artisan fishermen of Costa Rica were examined microbiologically to determine changes in quality from initial landing to point of sale. Ice and surfaces coming into contact with the fish were also inspected. This information was taken to indicate areas needing improved handling practices. The artisan fishery is of importance to Costa Rica in that it supplies needed protein to the population, while the commercial fishery supplies fish primarily for export.

This study shows that methods of fish handling do need to be improved. Total bacterial counts were abnormally high, as were numbers of coliforms and staphylococci. This indicates unsanitary handling conditions. For short trips, fishermen store their catch without ice until they arrive on land. On longer trips, the catch may be iced, but the holding area is usually not clean. After landing on short trips, fishermen mix the fish with ice in boxes or "neveras" where the fish are stored about two days until they are transported to market. The ice and water in these neveras become highly contaminated with bacteria as do the fish stored in them. The fish are then loaded on trucks and taken to market where they are displayed on wooden tables. Rough treatment and unsanitary conditions lead to continued deterioration.

Several recommendations can be made to improve handling procedures. Fish should be iced immediately upon capture and stored only a short time in the neveras. More ice needs to be added before the fish are transported and care taken to place the fish in shallow layers to decrease the pressure on fish stored on the bottom. Ice in the neveras and at the marketplace needs to be replaced more frequently and protected against contamination. A nonporous surface, easily cleaned, should be substituted for wood. In addition, the fish should be kept in ice until sold.

The fishery resource of Costa Rica could, with these precautions, be used more efficiently and provide fish of better quality with wider distribution.

Introduction

Artisan fisheries contribute to the economy and nutritional well-being of Costa Rica. Therefore, losses of fish in this sector through

mishandling and spoilage have far-reaching consequences. Before these losses can be reduced, some idea of their extent and underlying causes are needed. It is hoped that this study of the small-scale fishery will help provide some of this information.

Deterioration of fish is caused by autolytic processes, oxidation and microbial activity, with the latter being the most important (Shewan, 1976). In order to obtain information on the extent of bacterial spoilage of fish in Costa Rica, microbiological studies were conducted on three fish species. Samples of fish were taken (1) at capture, (2) when placed in ice at the receiving station, and (3) when displayed for sale. See Figure 1 for the position of these sampling points in the entire distribution process. Three of the predominant fish species caught by the artisan fishermen in the Gulf of Nicoya were selected for this study:

Corvina Aguada (Cynoscion spp.)
Corvina Agrica (Micropogon spp.)
China (Stellifer spp.)

Fishing in Costa Rica is still carried out largely using traditional methods and gear. Fishermen live near each other on the islands in the Gulf of Nicoya and in the coastal city of Puntarenas, close to the fishing grounds. Fishing areas are shown in Figure 2. The capture methods used in the artisan fishery of the Gulf of Nicoya are:

a. Longlines or handlines, primarily used by the inhabitants of the islands fishing from small boats. The fishing grounds are close to the coast where the water is known to be contaminated.

b. Gill nets, used by the fishermen of Puntarenas fishing from larger boats. These nets are used to catch bottom fish primarily, though some nets float near the surface. This fishing is done further out in waters presumably less polluted.

Fishing takes place in the early hours of the morning or the late hours of the evening depending on the methods used. The catch is stored on the deck during the fishing period. Once fishing stops, the fish is eviscerated and the abdominal cavity is cleaned with a brush and washed in sea water. The fish may then be stored on ice in a box constructed on deck for that purpose. The fisherman, upon returning to land, transfers the fish to another ice box or "nevera" and resumes his activity. The temperature of the neveras was found to vary from 1°C to 19°C. The fish remain in the nevera until it is full, about two days, whereupon the fisherman takes the load of fish to Puntarenas where it is sold to wholesalers. The fish are transferred in plastic containers to the place of sale where they are emptied onto the wooden floor. Here, they are cleaned, classified according to odor by the buyer and weighed. The fish remain in ice for up to two days more, the temperature varying between 1°C and 19°C. They are then transported by truck to cities in the center of the country.

In addition to the initial bacterial load on the fish from the water in which it was caught, other sources of bacterial contamination include:

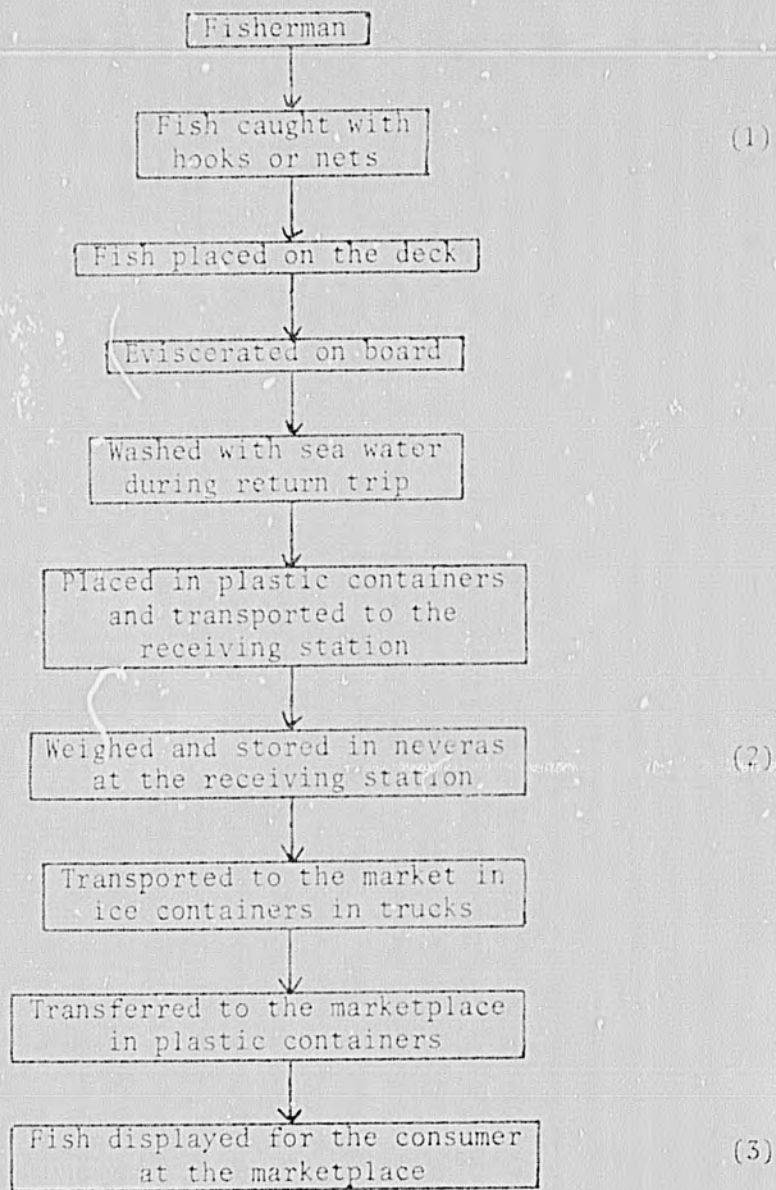
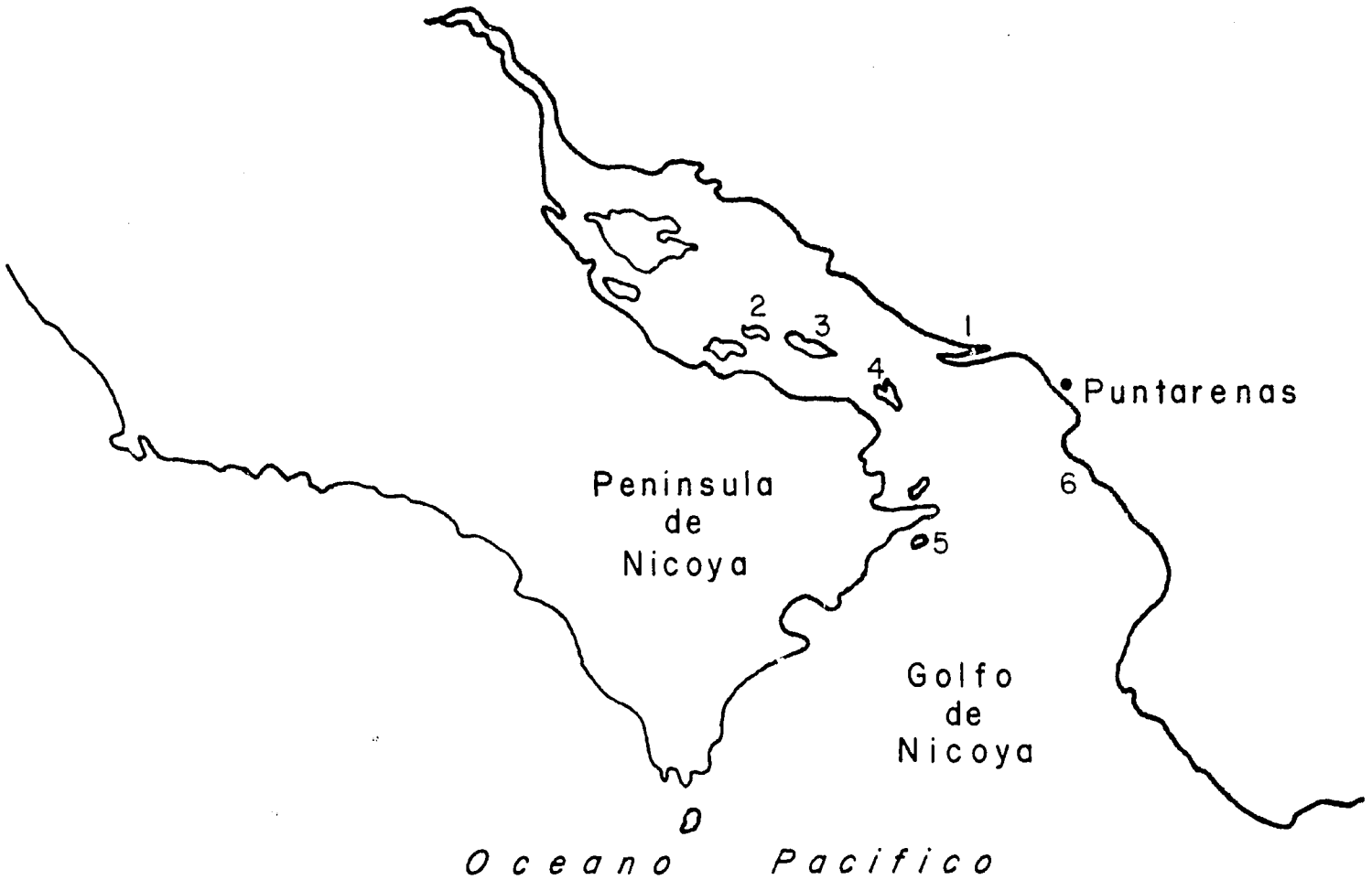


Figure 1. Flow diagram of the fish from landing to the point of sale. The numbers in parentheses show where samples were taken.

Figure 2 - Map Indicating different sites of capture in the Gulf



<u>Location</u>	<u>Description</u>
1	Departure from the harbor, the boats go near the beach.
2	Arrival at the fishing area, Bejuco Island.
3	Arrival at the fishing area, Caballo Island.
4	Capture near Naranjo beach.
5	Arrival at the fishing area, Negritos Island.
6	Arrival at the fishing area.
1	Return to the point of departure and to the point of sale.

1. The water used to wash the fish;
2. Ice which comes in contact with the fish over a long period of time;
3. Tables or boards used in the preparation of fillets in the fish market; and
4. Liquid and drippings in the boats and in the neveras.

The results of this study indicate that the fish is highly contaminated by the time it is sold. Fish sold in the fish market of Valle Central do not appear to merit the term "fresh" used in its sale. It exhibits spoilage characteristics including caved-in eyes, opaque corneas, soft flesh, sour odor, easily-removed scales. Recently captured, truly fresh fish has no odor, little mucous, firm flesh and intact scales. In general, handling procedures for fish could be improved in all areas from the time of capture until the fish are sold.

Materials and Methods

Sampling Procedure

Fish samples were collected initially at the point of capture, next at an intermediate collecting point, and finally following arrival at the fish market. The time between sampling and culturing was reduced to the minimum to avoid significant changes in the bacterial populations which would have made results meaningless. Noting the location of capture (see Figure 2), approximately 12 trips were made in small fishing boats in the Gulf of Nicoya. During three of these trips, samples were taken with one trip per species. The captured fish of the desired species were tagged but treated normally until they reached the marketplace. Samples were taken aseptically from different areas of the skin and body cavity using the swab method. A sterilized aluminum template (80 x 70 x 3 mm) was pressed against the surface of the skin and microorganisms taken up with the swab from this area (Yokoya and Zulzke, 1975). The swabs were inserted in screw-capped plastic tubes containing 0.1 percent peptone solution (Thatcher and Clark, 1968). Samples of wash water and ice were collected in sterile containers. All samples were placed on ice in insulated boxes and carried to the laboratory in the shortest time possible. Microbiological culturing was performed on the same day as sampling.

Bacteriological Examinations

Total aerobic counts were determined using serial dilutions of the sample in tryptone-glucose agar (Difco). The plates were incubated at $27^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 48 hours (I.C.M.S.F., 1974).

Coliform counts were made by plating serial dilutions of the same sample in Violet Red Bile Agar (Difco). Incubation was at $35^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 24 hours. In order to confirm the presence of faecal coliforms, typical colonies were inoculated in fermentation tubes of Lauryl tryptose (Difco). The incubation was at $35^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 24 hours (Sharf, 1972).

Staphylococcus aureus counts were made using plates previously prepared with Baird-Parker agar (Difco), distributing 0.1 ml of the appropriate serial dilution over the agar surface with a bent glass rod until absorbed. The plates were incubated at $35^{\circ}\text{C} \pm 1^{\circ}\text{C}$ for 48 hours. Selected colonies were then incubated in Brain Heart Infusion Agar (Difco) for 24 hours at $35^{\circ}\text{C} \pm 1^{\circ}\text{C}$ and tested for coagulase activity (USDA, 1974).

Results and Discussion

Table 1 shows the variation in the microflora in contact with the fish at the different locations of sampling. A high bacterial count was found in containers, ice and table surface at the fish market. The highest count was found on the tables and boards used to prepare the fillets. The high bacterial count found in the ice is not surprising since the same ice is reused until it melts. Coagulase-positive staphylococci were found in the residual liquid of the boat and in the drip at the fish market. Such unsanitary conditions must affect the bacterial numbers on the fish when purchased by the consumer.

In Table 2, bacterial counts on three fish species at the three sampling points are presented. Samples of corvina aguada and china present an initial bacterial load which is higher than the samples of corvina agria. The first two species were captured near the islands of Bejuco and Caballo which are in the more contaminated waters of the Gulf. Corvina agria was captured outside the Gulf of Nicoya. The fish were left for an hour or more until the total catch was collected. After being put on ice, the temperature of these fish was found to vary between 1°C and 19°C . This would facilitate bacterial deterioration. Coliform counts varied little between 10^3 and 10^5 except for the corvina agria which showed no coliform contamination initially. The samples of corvina agria showed signs of contamination by coliforms after storage in the ice containers at Punta-renas, possibly because at that point all the species are mixed together. Coagulase positive staphylococcus were found in some of the samples stored at the fish markets.

This study, while exploratory in nature, does demonstrate a lack of adequate sanitary practices in the artisan fishery of Costa Rica. It is of special interest now because Costa Rica is setting up its first "National Fisheries Plan" in an effort to increase the quantity and quality of food from marine sources. It is felt that more thorough studies should be conducted along these lines. These would cover larger areas and more species so that proper recommendations for handling and processing might be made. Thus, fish from the Costa Rican coast would be used more efficiently to feed the Costa Rican people and strengthen the economy.

Table 1. Total bacteria count in samples taken at the different stages of handling.

Sample	Total count of aerobic bacteria N ^o /ml	Coliform count N ^o /ml	Staphylococcus count N ^o /ml
Water used for washing fish before they reached selling area. ¹	129 x 10 ⁴	10 x 10 ²	--
Liquid from the ice container at the selling area.	62 x 10 ⁶	90 x 10 ²	--
Water used for washing at the receiving area.	29 x 10 ⁵	39 x 10 ²	--
Residual liquid in the boat.	150 x 10 ⁶	76 x 10 ³	129 x 10 ^{1*}
Ice in the container (Puntarenas).	80 x 10 ⁵	32 x 10 ¹	160 x 10 ¹
Ice in the fish market (San Jose).	200 x 10 ¹⁰	141 x 10 ³	100 x 10 ²
Table at the fish market. ²	118 x 10 ¹¹ /cm ²	86 x 10 ³ /cm ²	59 x 10 ⁶ /cm ²
Residual liquid at the fish market. ²	300 x 10 ¹²	46 x 10 ⁴	80 x 10 ^{2*}

¹Sometimes water from the river was used for washing.

²Central market.

*Coagulase positive.

Table 2. Bacterial count expressed in N^0/cm^2 of the different species studied.

Species	Bacteria	0	Days of sampling (taken at 3 sampling points)			
			1	2	3	4
Corvina agria (<u>Micripago spp.</u>)	Total count	a. $4.5 \times 10^{2*}$	1.3×10^6	1.3×10^{10}	3.5×10^{12}	3.0×10^9
		b. 9.3×10^3	2.5×10^4	2.1×10^{10}	2.0×10^{12}	3.2×10^{14}
	Coliforms	a. -	3.9×10^3	2.8×10^4	4.9×10^4	8.7×10^4
		b. -	-	3.5×10^3	3.7×10^3	6.0×10^4
	Staphylococcus	a. -	8.3×10^2	9.3×10^2	$4.9 \times 10^{3*}$	$6.9 \times 10^{3*}$
		b. -	3.2×10^2	3.3×10^2	3.6×10^3	$1.1 \times 10^{3*}$
Corvina aguada (<u>Cynoscion spp.</u>)	Total count	a. 1.9×10^7	2.8×10^8	2.7×10^{10}	3.2×10^{12}	3.1×10^{14}
		b. 1.1×10^4	2.7×10^6	1.1×10^7	2.5×10^{11}	1.6×10^{14}
	Coliforms	a. 1.1×10^3	1.4×10^4	7.0×10^4	3.2×10^4	3.6×10^4
		b. 5.5×10^2	1.2×10^3	6.2×10^3	1.2×10^5	4.0×10^3
	Staphylococcus	a. 3.0×10^2	7.1×10^3	1.7×10^5	7.3×10^5	5.5×10^4
		b. 3.1×10^2	3.0×10^3	2.0×10^4	1.3×10^5	$9.0 \times 10^{2*}$
China (<u>Stellifer spp.</u>)	Total count	a. 1.1×10^6	2.1×10^7	3.4×10^{10}	1.4×10^{12}	1.7×10^{14}
		b. 1.9×10^5	8.3×10^5	3.2×10^{10}	3.0×10^{14}	3.1×10^{14}
	Coliforms	a. 4.1×10^3	4.9×10^3	4.9×10^4	4.6×10^4	3.3×10^4
		b. 4.8×10^2	3.0×10^3	6.1×10^4	3.2×10^4	3.6×10^4
	Staphylococcus	a. -	1.2×10^4	4.9×10^4	$8.0 \times 10^{5*}$	$1.2 \times 10^{4*}$
		b. -	4.0×10^2	1.6×10^4	4.3×10^4	9.4×10^4

a: Sample from skin.

b: Sample from body cavity.

0: Samples of fish as caught.

1,2: Days held in the ice container at the receiving station.

3,4: Days held in the fish market.

* Average of three determinations.

REFERENCES

- International Commission on Microbiological Specifications for Foods. 1974. Page 213 in Microorganisms in Foods 2. Sampling for Microbiological Analysis: Principles and Specific Applications. University of Toronto Press, Toronto, Canada.
- Sharf, J.M. 1972. Page 257 in Metodos recomendados para o exame microbiologico de alimentos. Ed. Poligono. San Paulo.
- Shewan, J.M. 1976. The bacteriology of fresh and spoiling fish and the biochemical changes induced by bacterial action. Torry Research Station, Aberdeen, Scotland.
- U.S. Department of Agriculture, Scientific Services. 1974. Animal and plant health inspection service. Microbiology Laboratory Guidebook, Washington, D.C.
- Thatcher, F.S. and D.S. Clark. 1968. Page 238 in Microorganisms in foods: their significance and methods of enumeration. University of Toronto Press, Toronto, Canada.
- Yokoya and Zulfke. 1975. Method for sampling meat surfaces. Appl. Microbiol. 29 (4):551-552.

Guatemala -- An Investigation into Fish Quality at the Marketplace in Guatemala City, Guatemala

Abstract

A two-part study was conducted to investigate sanitary conditions and fish quality at the retail level in Guatemala City, Guatemala. Microbiological quality was measured using the aerobic plate count (APC) at 35°C, most probable number (MPN) of faecal coliforms, and a count of Staphylococcus aureus. The APC, coliform and S. aureus counts were made for every fish sample, swabs of table and floor surfaces, and ice water and fish drippings. Since both coliforms and Staphylococci are not part of the normal flora of raw seafood, their presence is considered an indication of contamination from human sources.

The first part of the survey was a six-day study of the conditions under which fish are sold at two public markets. These sites generally lack modern equipment such as refrigerators, freezers, electrical saws or stainless steel tables. Swab samples of the skin and body cavity of three popular species of fish were taken. Ice and surfaces of tables and floor were sampled also. Results indicate that both the Colon Market and the Terminal Market have tables, floors and ice that are grossly contaminated. The drip from the piled fish is also heavily contaminated. Ice and drip are the most important factors contributing to high bacterial counts, since both are in contact with the fish and allow cross contamination. In spite of this contamination, at the end of three days, the APC of fish samples were $10^6/\text{cm}^2$ or less. The general appearance of the fish was good; no signs of spoilage were evident.

The second part of the study dealt with fish processed by filleting, freezing, drying or salting. Samples were collected from four supermarkets and one popular market. The microbial loads of the products as measured by the APC at 25°C were generally higher than the APHA permitted level; 72 percent of the samples showed a total count higher than $10^6/\text{g}$. Since the faecal coliforms and S. aureus counts also exceeded the APHA limits, mishandling was indicated.

Answers to several questions were recorded at each sampling site to complement the laboratory data. These questions concerned the source of fish, the means and condition of transport and storage, the amounts of fish rejected and criteria, use of ice, general sanitation practices and wholesale and retail prices.

Introduction

Fish is one of the foods of high nutritive value whose increased consumption would benefit the Guatemalan people. It is highly perishable

unless methods such as drying, salting or freezing are used. Ice continues to be the principal means of preservation of fresh fish but even this is not used to full advantage in the markets of Guatemala. To clarify the nature of the problem, it was decided to study the sanitary conditions of fresh and processed fish at the retail level in Guatemala City. To this end, a contract was signed between the Central American Research Institute for Industry (ICAITI) in Guatemala City and the International Center for Marine Resource Development (ICMRD) at the University of Rhode Island.

Sanitary conditions were measured microbiologically and a visual assessment was made at the time of sampling. Bacterial counts were measured using the aerobic plate count (APC) at 25°C, the most probable number (MPN) of faecal coliforms and a Staphylococcus aureus count. These three parameters were studied in every sample, including fish, table and floor surfaces, ice water and fish drippings. Because coliforms and staphylococci are not part of the normal flora of raw seafood, their presence is taken to indicate contamination from human sources.

The work covered by the contract was done in two parts. The first part was a study of the conditions of retail sales of fresh fish at two public markets over a six-day period. The fish sampled remained at the place of sale under conditions normally found there. These sites generally lack modern equipment. Instead, working areas may contain a large wooden or cement table, another small table where fish are cleaned and cut, and generally a wooden chest lined with galvanized tin to keep fish with ice. If there is no such ice chest, cane baskets lined with plastic are usually used with "pacaya" leaves as insulation.

The second part of the study dealt with the microbiological conditions of fish that had received some type of processing such as freezing, filleting, drying and/or salting. Frozen fish is distributed by small fishing companies as whole or filleted fish. Dry fish is prepared at the artisan level and is found in Guatemala in large amounts only during Holy Week. In this part of the study, four supermarkets and one popular market were visited. To complement the laboratory data, several questions were asked at each market or supermarket about the source of fish, the means and conditions of transport and storage, the amounts of fish rejected and criteria, the use of ice, general sanitation practices and wholesale and retail prices.

Materials and Methods

Sampling procedures and analytical methods used were those recommended by the International Committee on Microbiological Specifications for Foods (Thatcher and Clark, 1968). During part one, the study of two municipal markets, the fish were purchased but remained at the place of sale for four days to be sampled under normal conditions. Each day a swab sample of the skin surface and of the body cavity were taken. This involved the use of a sterile metal square that circumscribes a 15 cm² area. The swab was moistened with a sterile peptone solution (0.1 percent), moved over the surface and replaced in its tube with 5 milliliters of peptone water. In the second part, samples of processed fish were purchased from four

supermarkets and one municipal market and transported to the laboratory in the original packaging (if any). Bacteria on freezer surfaces were sampled using the swab technique.

Aerobic Plate Count (APC)

The APC was carried out following the pour plate method of Thatcher and Clark (1968) with a lower incubation temperature of 25°C. Both psychrophiles and mesophiles were of interest. The three-day incubation period originally planned proved impossible in practice, since in that time spreaders and giant colonies developed. A 48-hour incubation period was used instead.

Faecal Coliforms

Determinations of the most probable number (MPN) of faecal coliforms were performed using the procedure of Thatcher and Clark (1968) with no further modifications. This count was seen as a measure of sanitation.

Staphylococcus Aureus Count

The method of Thatcher and Clark (1968) was followed with no further modifications. This count was taken to demonstrate mishandling of the fish.

Results and Discussion

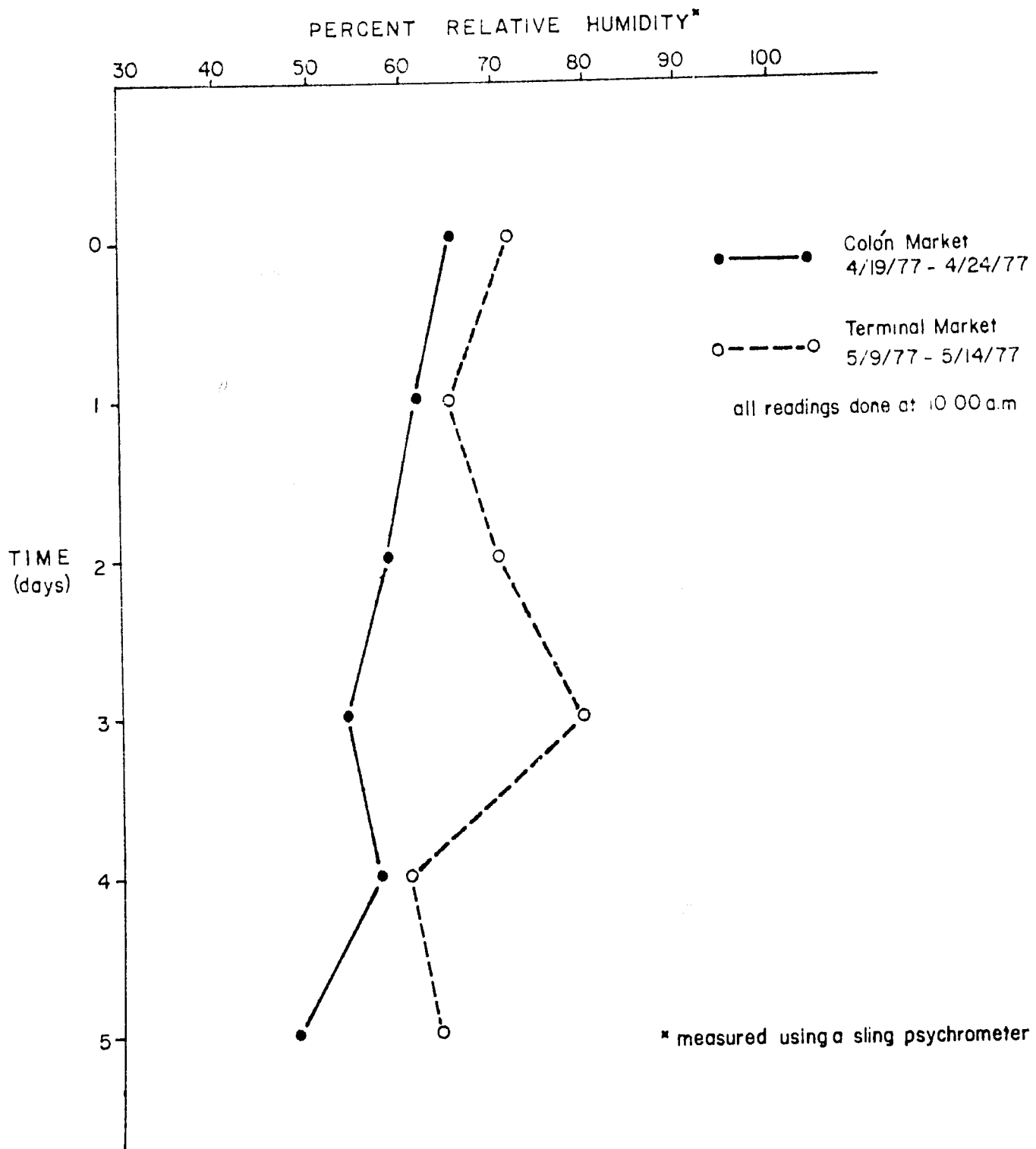
Description of the Places Visited

Brief descriptions of the markets follow. Graphs 1 and 2 show the temperatures and relative humidity at the markets when the samples were taken at 10:00 a.m. each morning. Responses to the questionnaire are presented in Appendices A and B.

Colon Market. This is a popular market located in one of the older quarters of the city. The large, high-ceilinged building is divided into two main sections, one where vegetables and staples are sold and the other housing tiny restaurants or "comedores" and butcher shops. Like other markets, the place is crowded with small stalls where selling takes place. There is no specific area where fish vendors are located. Of the three stands where fish are sold, two are located with the comedores and butcher stalls in the hallways and the other is located among the vegetable stands.

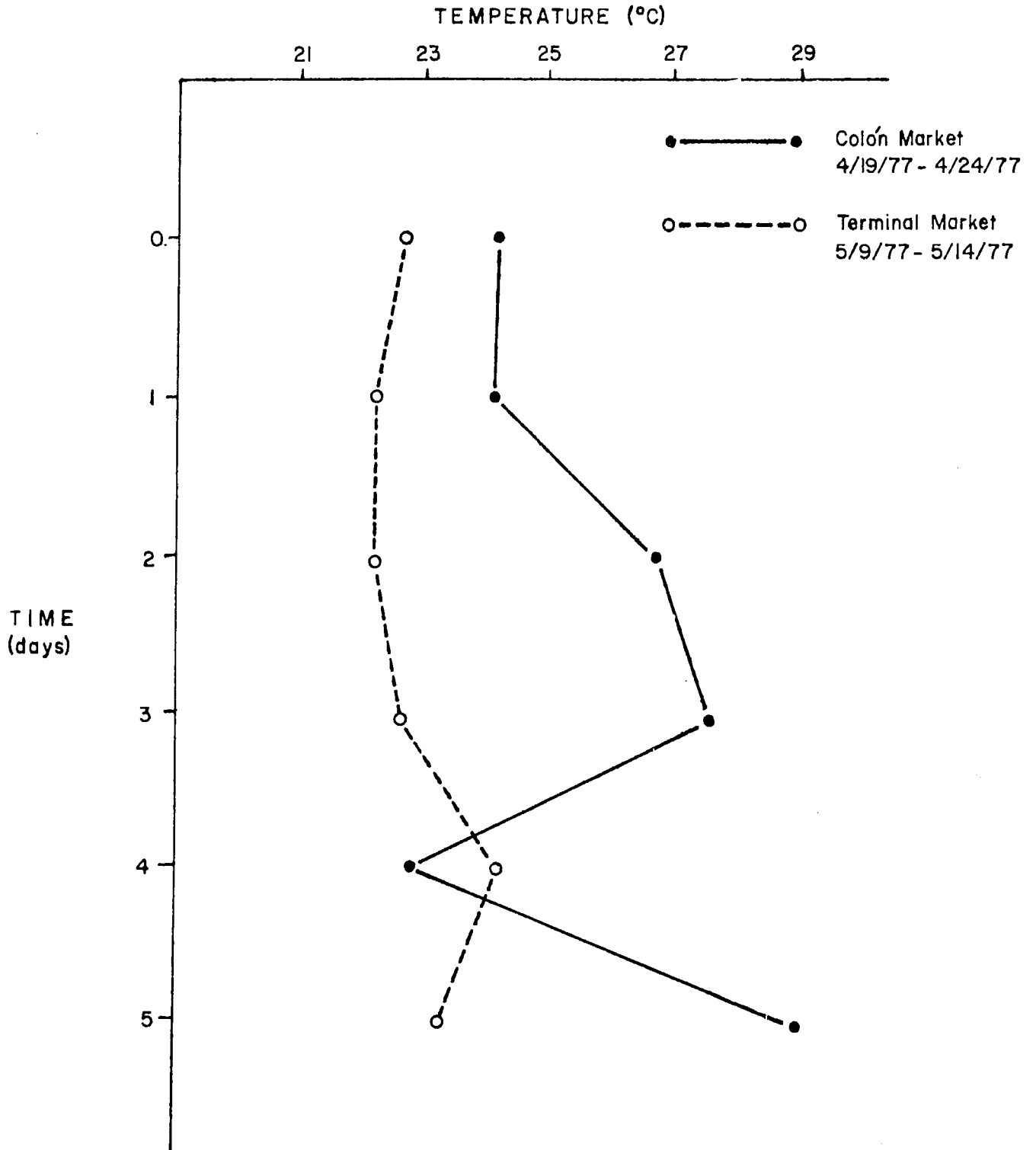
The fish stand selected for study is owned by a woman who cares for it with the help of her daughter. The place allows only a narrow passage way for shoppers and it is difficult to stay in front of the stand to purchase seafood. This made sample collection difficult. Although there are windows, natural light is scarce because of walls separating the stalls, and the smoke from the kitchens that has deposited soot on the walls and window panes over the years. No artificial light is available in the stand.

Graph 1. % of Relative Humidity at the Popular Markets During the Six Day Study Period



Graph 2.

Temperature at Markets



The area was infested with flies that continuously landed on the seafood, tables and scale. No control measures were taken to solve the problem. Since the stand does not occupy a stall, there is no water available. It has to be collected in cans from a central faucet. The people in charge use a large knife and a utensil made from wood and nails to scale and fillet the fish. Both items are rarely washed and never disinfected. The table is made of wood and the surface is full of cuts from the use of the knife. Ice is bought in big chunks and is broken by the people there. Because the pieces are still too large, there is poor distribution of ice around the fish. When the fish are stored overnight, they are put in a large wooden ice chest lined with galvanized metal and covered with leaves and plastic.

La Terminal Market. This market was designed to function as a wholesale distribution center, receiving products from the countryside and then distributing them to retail markets in different parts of the city. However, at present it also functions as the largest retail market in Guatemala.

There is a specific area for selling seafood and the stalls are built for that purpose. Each stand has cement benches covered with glazed tiles and a source of tap water. There is a great variety of seafood items on display, not only from Guatemala but also from El Salvador. Even though the installations are adequate, vendors do not use them correctly. In many cases, the benches are covered with plastic which prevents proper drainage. As in the Colon Market, flies are abundant and the problem of light is even more severe. The ceiling is low and the windows are covered with cardboard, since the panes are probably broken.

The fish stand chosen for study is owned and operated by a young couple. Even though there are tap water facilities, the vendors do not use this lavatory but instead wash items by dipping them in a huge bowl. The water in the bowl was turbid. The seafood is prepared for sale on a wooden table; the table and filleting tools were not cleaned or disinfected during the time the samples were collected.

Ice is used in large chunks that are placed with the shellfish; no pieces of ice were observed with the other fish. The temperature of the fish was 9°C. The ice to be sold is prepared at the market entrance. Large rectangular pieces are cut into smaller pieces to be sold to the fish stands. The ice is prepared on a wooden platform outside the market on the street exposed to dust. At the stand, fish was stored overnight in cane baskets lined with plastic and pacaya leaves. It was the only time observed when fish were placed between layers of ice.

La Placita Market. This market is centrally located and was formerly much larger, part of it being destroyed by fire. It is in a tall building with a high ceiling with windows providing good illumination. Here it was possible to sample the dried-salted fish that is consumed in the days preceding and during Holy Week. The fish stand is located in an area where many different items are on sale in neighboring stands. The dried-salted fish were piled on wooden tables against a wooden counter, without any kind of packaging. There is no running water and occasional cleaning is carried out using a damp cloth.

The Supermarkets. The supermarkets sampled were located in different parts of the city. In general, they had similar sanitary conditions. They all had an open freezer where fish were placed for sale. The supermarkets are listed in Table 7 with a list of samples taken and the price per kilogram of fish species sampled.

At two supermarkets, Norte and La Torre, fish were not distributed in an orderly fashion in the freezer and some opened bags were found. In both these supermarkets no one could give us information on the fish for sale. In many cases, bags of whole fish carried no identifying label and were of unknown species. Also there were some unpackaged fish for sale, mixed with the packaged fish. The same printed plastic bag was used for packing different kinds of fish fillets so the contents could not be identified as to species.

Results and Discussion

Parts one and two are discussed in the following pages. The results for each individual sample can be found in Table 1 through 8 (pp.21-29).

In phase one, two popular markets were studied for six days to obtain a picture of daily sanitary conditions so that the effects on the quality of fresh, chilled fish sold there would also be known. In each market, three of the most popular species of fish were chosen and sampled by swabbing the skin and body cavity surfaces. The fish remained in the market and were sampled daily for several days.

Results indicate that the Colon Market has tables, floors, and ice that are grossly contaminated. The liquid drippings from the piled fish are also heavily contaminated (Tables 1, 2 and 3). Ice and liquid drippings would seem to be the most important factors resulting in high counts since both are in contact with the fish and can be a source of cross contamination. In spite of these conditions, at the end of three days, the APC of fish samples were $10^6/\text{cm}^2$ or less, even inside body cavities. (According to the American Public Health Association (APHA, 1976), figures higher than 10^6 per gram or cm^2 are considered indicative of incipient spoilage.) The general appearance of the fish was also good; no signs of spoilage were evident.

The location at the other market, La Terminal, was similar. The most heavily contaminated samples were ice and liquid drippings (Tables 4, 5 and 6). Fish sampled were in the market for four days and were spoiled at the end of the trial. Because the exact day of their arrival at the market was unknown, they could have been in ice longer than assumed. One of the problems in markets is the tendency of people selling fish to cover tables and benches with plastic allowing water to accumulate. In this market, the failure to allow for good drainage is unnecessary since vendors have a cement bench covered with glazed tiles with proper inclination and drainage facilities; yet the drain is covered with plastic.

During part two, the purpose of sampling the processed fish was to check the microbiological condition of the products and the markets. In frozen fish, all samples are sold in plastic bags so there is no real contact

between the freezer walls and the fish. In only one place, Supermarket Paiz Montufar, unpackaged frozen fish is displayed on ice, not for preservation but to keep the fish surface wet and shiny for ornamental reasons. Dried-salted fish is displayed without refrigeration or packaging of any kind. In Table 7, samples taken are listed with current prices of the fish.

The microbial loads of the products, as measured by the aerobic plate count (APC) at 25°C are shown in Table 8. Most samples consisted of filleted and frozen fish. As can be seen in Table 8, samples from two supermarkets, Norte and La Torre, have products with APC results in order of 10^7 per gram.

In the case of La Placita where only dried-salted fish was sold, the situation is similar. Counts in excess of 10^6 per gram suggest improper handling conditions in processing and storage. If faecal coliforms are in excess of 10/g for frozen fish and 40/g for salted dried fish, it is supposed that products have been subjected to mishandling (APHA, 1976). Staphylococcus aureus should not be in excess of 10^2 /g; higher counts are also indicative of mishandling. As can be noted in Table 8, there are samples where both these indicators, faecal coliforms and S. aureus, are in excess of the limits.

The need for improved conditions in Guatemalan fish markets is evident from this study. Yet even with improved conditions, it is important that vendors become aware of the importance of their role in preserving fish quality. With increased interest and understanding of their role, facilities which are adequate will be used more effectively to supply fresh and processed fish to the people of Guatemala.

REFERENCES

Compendium of methods for the microbiological examination of foods. 1976.
Edited by M.L. Speck. APHA Inc., Washington, D.C. 701 p.

Thatcher, F.S. and D.S. Clark. 1968. Microorganisms in foods. International Committee on Microbiological Specifications for Foods. University of Toronto Press, Toronto, Canada. 234 p.

Part 1 -- Fresh Fish

Table 1. Aerobic plate count at 25°C per cm² or per ml* -- Colon Market.

Sample	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
A Juilin skin surface	3.8x10 ⁴	7.3x10 ⁵	6.4x10 ⁵	--	--	--
B Juilin cavity surface	1.6x10 ⁴	1.0x10 ⁶	1.9x10 ⁶	--	--	--
C Palometa skin surface	4.5x10 ⁵	2.6x10 ⁶	1.0x10 ⁶	--	--	--
D Palometa cavity surface	4.6x10 ⁴	8.0x10 ⁵	7.3x10 ⁵	--	--	--
E Pepemechin skin surface	1.9x10 ⁵	1.3x10 ⁶	8.6x10 ⁵	--	--	--
F Pepemechin cavity surface	8.6x10 ⁴	8.0x10 ⁵	1.8x10 ⁶	--	--	--

G Floor surface	1.8x10 ⁶	2.4x10 ⁶	1.5x10 ⁶	3.2x10 ⁶	3.8x10 ⁶	3.5x10 ⁶
H Table surface	1.4x10 ⁶	1.6x10 ⁶	2.8x10 ⁶	1.9x10 ⁶	3.9x10 ⁶	6.6x10 ⁵
I Water *	<10 ³	8.0x10 ⁴	<3.0x10 ¹	7.0x10 ¹	7.0x10 ⁵	1.9x10 ⁴
J Ice *	2.7x10 ⁶	3.4x10 ⁶	1.3x10 ⁷	4.7x10 ⁶	4.3x10 ⁶	1.9x10 ⁷
K Fish-ice drippings *	3.6x10 ⁷	1.1x10 ⁸	7.0x10 ⁷	9.3x10 ⁷	2.5x10 ⁸	5.0x10 ⁷

Part 1 -- Fresh Fish

Table 2. Faecal coliforms count as MPN per cm² or per ml* -- Colon Market.

<u>Sample</u>	<u>Day 0</u>	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>	<u>Day 4</u>	<u>Day 5</u>
A Juilin skin surface	3	15	0	--	--	--
B Juilin cavity surface	10	160	60	--	--	--
C Palometa skin surface	1.5	30	0	--	--	--
D Palometa cavity surface	3	0	0	--	--	--
E Pepemechin skin surface	1	15	150	--	--	--
F Pepemechin cavity surface	.73	4.8	150	--	--	--

G Floor surface	73	310	60	60	2.4	24
H Table surface	31	73	0	24	6	0
I. Water *	0	930	0	0	390	0
J Ice *	1100	150	360	0	430	730
K Fish-ice drippings *	>2400	2400	4300	9300	>2400	4300

Part 1 -- Fresh Fish

Table 3. Staphylococcus aureus cell count per cm² or per ml* -- Colon Market.

Sample	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5
A Juilin skin surface	0	70	7	--	--	--
B Juilin cavity surface	0	0	0	--	--	--
C Palometa skin surface	0	0	0	--	--	--
D Palometa cavity surface	0	1	0	--	--	--
E Pepemechin skin surface	0	0	0	--	--	--
F Pepemechin cavity surface	0	1	0	--	--	--

G Floor surface	0	70	0	0	70	700
H Table surface	0	1	700	7	0	70
I Water *	0	0	0	0	0	0
J Ice *	0	10 ³	10 ²	10 ²	0	10 ²
K Fish-ice drippings *	0	0	0	10 ³	10 ⁴	10 ³

Part 1 -- Fresh Fish

Table 4. Aerobic plate count at 25°C per cm² or per ml* -- La Terminal Market.

<u>Sample</u>	<u>Day 0</u>	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>	<u>Day 4</u>	<u>Day 5</u>
A Roballo skin surface	2.4x10 ⁶	5.2x10 ⁶	1.13x10 ⁷	1.2x10 ⁷	--	--
B Roballo cavity surface	2.5x10 ⁷	8.6x10 ⁶	1.5x10 ⁷	2.0x10 ⁷	--	--
C Mojarra skin surface	1.6x10 ⁶	5.6x10 ⁶	3.5x10 ⁶	1.9x10 ⁷	--	--
D Guapote skin surface	1.2x10 ⁶	6.6x10 ⁶	1.3x10 ⁷	1.6x10 ⁷	--	--

E Floor surface	2.2x10 ⁷	1.1x10 ⁶	2.4x10 ⁶	5.6x10 ⁶	1.1x10 ⁶	1.4x10 ⁶
F Table surface	2.4x10 ⁷	2.4x10 ⁶	5.5x10 ⁶	1.4x10 ⁷	8.0x10 ⁶	1.0x10 ⁶
G Ice *	4.1x10 ⁷	3.1x10 ⁷	3.3x10 ⁷	1.0x10 ⁸	1.3x10 ⁷	8.4x10 ⁷
H Water *	2.0x10 ¹	4.0x10 ¹	2.5x10 ¹	5	0	0
I Fish-ice drippings *	2.0x10 ⁷	4.0x10 ⁸	4.3x10 ⁸	3.9x10 ⁸	1.6x10 ⁹	2.0x10 ⁹

Part i -- Fresh Fish

Table 5. Faecal coliforms count in MPN per cm² or per ml* -- La Terminal Market.

<u>Sample</u>	<u>Day 0</u>	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>	<u>Day 4</u>	<u>Day 5</u>
A Roballo skin surface	31	160	31	62	--	--
B Roballo cavity surface	31	31	6.2	15.3	--	--
C Mojarra skin surface	73	31	14	160	--	--
D Guapote skin surface	>160	>160	73	62	--	--

E Floor surface	>160	31	31	160	6	4.6
F Table surface	>160	8	>160	733	2.6	15.3
G Ice *	>2400	240	1100	930	230	2400
H Water *	0	0	0	0	0	0
I Fish-ice drippings *	>2400	2100	11000	1500	>24000	>24000

Part 1 -- Fresh Fish

Table 6. Staphylococcus aureus cell count per cm² or per ml* -- La Terminal Market.

<u>Sample</u>	<u>Day 0</u>	<u>Day 1</u>	<u>Day 2</u>	<u>Day 3</u>	<u>Day 4</u>	<u>Day 5</u>
A Roballo skin surface	0	0	0.6	0	--	--
B Roballo cavity surface	0	0	0	10 ¹	--	--
C Mojarra skin surface	0	0	0	0	--	--
D Guapote skin surface	--	0	6.6x10 ¹	0	--	--

E Floor surface	0	0	0	0	0	10 ¹
F Table surface	0	0	0.6	0	0	10 ³
G Ice *	0	0	10 ¹	10 ¹	10 ¹	10 ²
H Water *	0	0	0	0	0	0
I Fish-ice drippings *	0	0	10 ²	10 ⁴	0	10 ²

Part 2 -- Processed Fish

Table 7. Samples taken at each supermarket and prices of the fish in U.S. dollars per kilogram.

Place	Identification*	US \$/Kilogram**
Paiz-Montufar Supermarket (PM)	Corvina fillets	3.19
	Roballo slices	3.30
	Dried roballo	2.84
	Whole corvina	1.54
	Ice	--
La Placita Market (LP)	Dried roballo	3.30
	Dried juilin	1.76
	Dried codfish	2.75
	Table surface	--
	Counter surface	--
Residential Supermarket (R)	Corvina fillets	3.30
	Whole salmonete	0.55
	Pristis perotetti	2.86
	Front wall of freezer	--
	Back wall of freezer	--
Norte Supermarket (N)	Whole salmonete	0.46
	Corvina fillets	3.52
	Pristis perotetti fillets	2.33
	Side wall of freezer	--
	Back wall of freezer	--
La Torre Supermarket (LT)	Pristis perotetti fillets	2.49
	Corvina fillets	2.42
	Corvina fillets	2.42
	Corvina fillets	2.42
	Unidentified fish fillets	1.36

*All samples frozen unless otherwise indicated.

**For comparison, the average price for fresh, whole Corvina agria and China in Costa Rica from May to June of 1977 was \$2.05/kilo while the price for Corvina aguada fillets was \$4.82/kilo.

Part 2 -- Processed Fish

Table 8. Bacterial counts of supermarket samples.

Samples		Sample Location	APC Colonies/gram	Faecal coliforms MPN/gram	<u>S. aureus</u> Coagulase+/gram
Frozen fish	Corvina fillets	PM	9.8×10^5	23	0
	Corvina fillets	R	6.3×10^6	7.3	10^2
	Corvina fillets	N	3.4×10^5	7.3	10^2
	Corvina fillets	LT	1.4×10^7	150	10^2
	Corvina fillets	LT	1.4×10^7	150	0
	Corvina fillets	LT	6.6×10^5	23	10^2
	Unidentified fillets	LT	3.5×10^6	23	0
	Roballo slices	PM	2.7×10^5	23	0
	Pristis perotetti fillets	N	5.3×10^7	460	10^2
	Pristis perotetti fillets	LT	5.3×10^7	0	10^1
	Whole corvina	PM	3.7×10^6	7.3	10^3
	Whole salmonette	R	2.5×10^4	0	10^2
	Whole salmonette	N	1.3×10^7	0	0
	Pristis perotetti	R	6.9×10^6	460	10^3
Dried fish	Roballo	PM	1.5×10^4	0	0
	Roballo	LP	2.3×10^6	3.6	0
	Juilin	LP	2.4×10^6	0	0
	Cod	LP	1.2×10^7	0	10

Table 8. Bacterial counts of supermarket samples (cont.).

Samples		Sample Location	APC Colonies/gram	Faecal coliforms MPN/gram	<u>S. aureus</u> Coagulase+/gram
Ice and surfaces	Ice	PM	1.6×10^5 /ml	0/ml	10/ml
	Table surface	LP	5.0×10^4 /cm ²	0/cm ²	6.6/cm ²
	Counter surface	LP	1.6×10^2 /cm ²	0/cm ²	0/cm ²
	Front freezer wall	R	8.0×10^6 /cm ²	0	0
	Back freezer wall	R	1.3×10^1 /cm ²	0	0
	Side freezer wall	N	0	0	0
	Back freezer wall	N	0	0	0

APPENDIX A

QUESTIONNAIRE RESULTS FOR MARKETS SELLING FRESH FISH

<u>Place surveyed</u>	<u>Colon</u>	<u>Terminal</u>
How are the fish delivered to market?	Wooden boxes with ice and sawdust; fish are bought at Terminal market.	Wooden boxes with ice and cane baskets with ice.
How are the fish displayed?	On a wood table with small amount of ice. The table is covered with plastic.	On a cement table covered with glazed tile with small amount of ice. Although the table has a drain, plastic is placed over it.
Washing of fish.	All fish are washed with ice-water (melted ice).	Only when ice is dirty.
Rejections.	Occasionally, on basis of texture, gill odor, cavity color.	Occasionally, on basis of texture, slime.
Ice for storage.	Yes.	Yes.
Relation: ice to fish.	They buy 75 pounds of ice per each 50 pounds of fish but it is not properly distributed with the fish.	About 1:1 by volume. Ice is properly placed in layers over and under fish.
Is the storage chamber adequate in size?	Large enough for the amount stored.	--
How is the fish placed in the chamber?	Inside plastic bags and papaya leaves for insulation.	Sandwiched between layers of ice.
Storage time.	Maximum two days.	Maximum three days.
Retail side conditions.	Wood bench plastic covered without drain. No tap water at the site. Water is brought in from a faucet in small cans. No place to wash hands, fish or instruments. A large knife and nail brush to scale fish but seldom washed or disinfected.	They have running water (chlorinated) but use a large tub where they wash instruments, knife and nail brush. Table where seafood is cut and scaled is not clean and is made of wood. Flies are abundant.

APPENDIX A

QUESTIONNAIRE RESULTS FOR MARKETS SELLING FRESH FISH (CONT.)

<u>Place surveyed</u>	<u>Colon</u>	<u>Terminal</u>
Observations.	<p>The place is dark with not enough room. Table for cutting and scaling fish is not clean and is made of wood. Weighing scale is also not clean. Flies are abundant.</p> <p>People in charge have years of experience and differentiate among different kinds of fish. Almost all merchandise is fresh fish.</p>	<p>Sale of various kinds of seafood besides fresh fish, turtle eggs, sea water and fresh water, shrimp, crabs and molluscs. Prices during the week of survey were fluctuating because of a nationwide strike by meat producers and distributors.</p>

APPENDIX B

QUESTIONNAIRE RESULTS FOR PROCESSED FISH SAMPLES

<u>Place surveyed</u>	<u>Paiz-Montufar Supermarket</u>	<u>Residential Supermarket</u>	<u>Norte Supermarket</u>	<u>La Torre Supermarket</u>	<u>La Placita Market</u>
Products sold	Frozen fish	Frozen fish	Frozen fish	Frozen fish	Solid, dried fish
How are the fish delivered to the store?	Wooden boxes with ice in insulated truck	Plastic bags in refrigerated truck	Plastic bags in small vans	Personnel questioned were not sure	Dried fish in nets in ordinary trucks
How are the fish displayed?	Open freezer. Whole, eviscerated fish, fillets in plastic bags.	Open freezer.	Open freezer.	Open freezer.	On a wooden table rough surface, uncovered.
Are fish washed?	No.	No.	No.	No.	No.
Rejection criteria.	i. Firmness ii. Color iii. Odor	Odor, gill color.	Gill color.	Personnel questioned were not sure.	Rejection uncommon.
Storage.	Frozen fish is kept overnight in closed freezer.	In the same freezer.	In the same freezer.	In the same freezer.	Covered burlap bag and tied with rope.
Ice.	Used to wet surface, preservation relies on freezer.	Not used.	Not used.	Not used.	Not used (dried fish).
Relation Ice:Fish	Not important	Not applicable.	Not applicable.	Not applicable.	Not applicable.

APPENDIX B

QUESTIONNAIRE RESULTS FOR PROCESSED FISH SAMPLES (CONT.)

Place surveyed	Paiz-Montufar Supermarket	Residential Supermarket	Norte Supermarket	La Torre Supermarket	La Placita Market
Relation Fish volume: chamber size in storage	They used closed cabinets and one room with refrigerator equipment.	Half full.	More than half full.	Half full.	Not applicable.
How are fish arranged in the storage box?	Piled according to kinds.	Piled according to kinds.	Piled according to kinds.	Piled at random.	Piled at random.
Maximum storage time before selling.	Four days.	One week.	One week.	One week.	Five days.
Description of retail site.	Freezing and chilling facilities. Place seems adequate with sufficient light. No disinfection is applied, only cleaning with detergents.	All fish are inside the display freezer, which seems to be clean but not disinfected. Light is adequate.	---	---	The place has no metal tables, only of wood. There are no refrigeration facilities. Light which comes from windows seems adequate. No disinfection. Cleaning is done rarely and poorly.

APPENDIX B

QUESTIONNAIRE RESULTS FOR PROCESSED FISH SAMPLES (CONT.)

<u>Place surveyed</u>	<u>Paiz-Montufar Supermarket</u>	<u>Residential Supermarket</u>	<u>Norte Supermarket</u>	<u>La Torre Supermarket</u>	<u>La Placita Market</u>
Other observa- tions.	Personnel in charge have ex- perience in han- dling fish and differentiate between genera (kinds). Fish sold is mainly filleted by com- mercial compa- nies or at the supermarket. Whole fish is sold frozen.	Almost all fish is processed by commercial fish companies. Once in a while fro- zen fish is fil- leted at the supermarket.	Almost all fish is processed by commercial fish companies. Once in a while fro- zen fish is fil- leted at the supermarket.	Filleted by com- mercial fish companies and some at the su- permarket. Sev- eral bags of fish were iden- tified and con- tents were of unknown species.	People in charge do not know how to dif- ferentiate between genera. In the sea- son when the survey was done, only dry fish was on sale.