

## STUDIES ON TRADITIONAL METHODS OF FISH SMOKING IN THE PHILIPPINES

by

M.A. Anenias, A.M. Mabeza, T.R. Miciano and E.C. Sison  
Department of Food Science & Technology, College of Agriculture  
University of the Philippines at Los Baños  
Laguna, Philippines

### *Abstract*

Traditionally smoked fish is very unstable and cannot be kept for more than a week without refrigeration. This study was conducted to explore ways of prolonging the shelf-life of smoked fish at room temperature.

Surveys were conducted on the methods of smoking fish in three areas of the Philippines. Samples were taken for chemical, i.e., nitrogen (TVN), thiobarbituric acid (TBA) and trimethylamine (TMA), and microbiological analyses to measure the rate of spoilage. Also, the smoking methods were simulated in the laboratory on five species to evaluate the general acceptability of the products.

The survey showed that methods of fish smoking are varied; this may be attributed to species differences, marketability and consumer preferences but, based on sensory evaluation, the different methods resulted in equally acceptable products.

The products deteriorated at varying rates depending on the moisture and salt content; those with high moisture and low salt content deteriorated more quickly. The TVN, TBA, and TMA values increased slightly during storage. Microbial counts increased with the storage; *Bacillus* and *Micrococcus* spp. predominated.

As a result of these studies new procedures are proposed. For small species and fatty fish, simultaneous cooking and hot smoking is recommended. Fatty fish should be split to enhance fat loss and dried before smoking in order to reduce moisture. Moreover, antioxidants and mould inhibitors may be used to prolong shelf-life.

### INTRODUCTION

Fish and fish products are a major source of protein in the Filipino diet. Most fish are consumed in the fresh form but some undergo processing particularly salting, drying and smoking. Traditional smoked fish is particularly popular in Luzon.

Previous studies and surveys on the processing of fish show that different methods of fish smoking are practised in different areas of the country (Guerrero and Medina, 1976), depending on the species, marketability, economic considerations and general consumer acceptability.

Large-scale processors are few; most smoked fish comes from small cottage level processors who produce only one day's supply because the products are unstable without refrigeration and they cannot afford refrigeration facilities. Smoked fish is acceptable for only two or three days.

This study was conducted in an attempt to prolong the shelf-life of smoked fish without refrigeration through improvements of the processing procedures.

#### MATERIALS AND METHODS

Fish smoking was surveyed in three areas of the Philippines namely: Mercedes, Camarines Norte; Rosario, Cavite; and Navotas, Metro Manila. . The flow charts of typical processes in each locality are given in Figs. 1, 2 and 3.

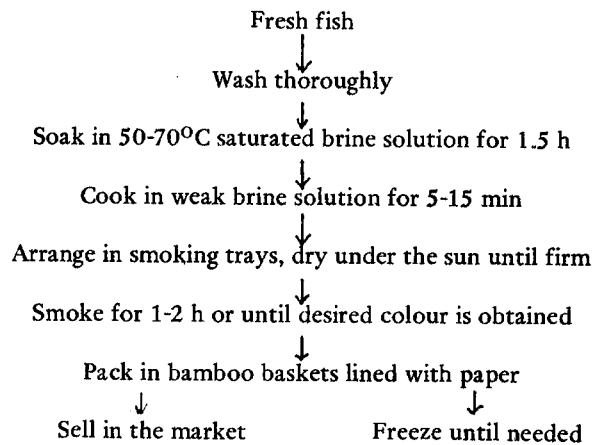


Figure 1. Method of smoking in Mercedes, Camarines Norte

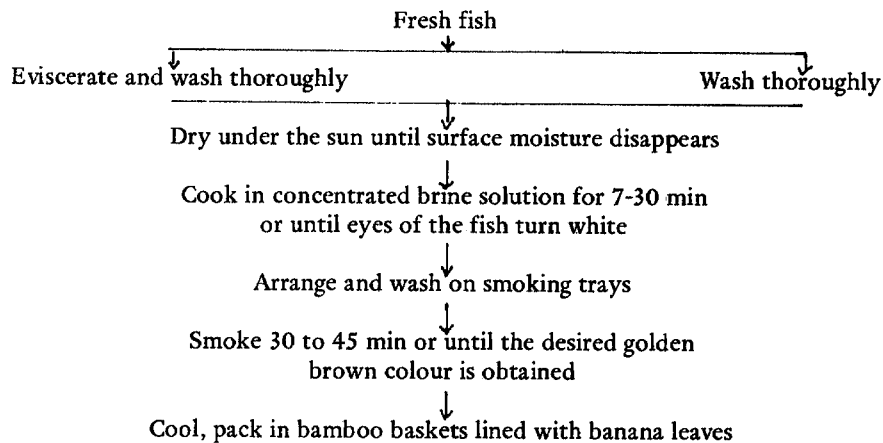


Figure 2. Method of smoking in Rosario, Cavite

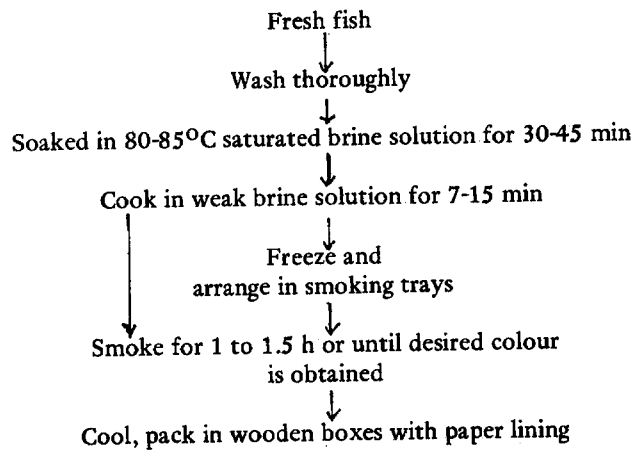


Figure 3. Method of smoking used in Navotas, Metro Manila

Smoked roundscad (*Decapterus macrosoma*), known locally as galonggong, were collected from different smokehouses. Samples were taken during processing to determine chemical and microbial changes. The samples were placed in clean, dry bottles and kept in ice during transport to the Department of Food Science and Technology.

The fish samples were filleted and comminuted prior to testing for: moisture and salt content (standard AOAC procedure), total volatile nitrogen (TVN) (Lucke and Geidel's macrodistillation method), trimethylamine (TMA) (Conway's micro-diffusion method), and thiobarbituric acid (TBA) values using the perchloric extraction of malonaldehyde.

Total plate counts were made during processing and storage and isolates were taken for further identification.

Consumer acceptability of the smoked fish was evaluated by a taste panel composed of departmental staff using the scorecard in the Appendix. Since it was desirable for all smoked fish samples to be presented at the same time, the different methods of smoking were simulated in the laboratory using 5 species of fish. The products were subjected to sensory evaluation one day after smoking. The mean panel scores for overall acceptability were analysed statistically using the analysis of variance technique.

## RESULTS AND DISCUSSION

### *Typical methods of fish smoking*

#### Sorting and cleaning of fresh fish

In Mercedes and Navotas, only small species of fish, ranging from 10 to 20 cm, are used for smoking; In Rosario, both large and small species of fish are smoked; the larger species are eviscerated prior to processing.

#### Drying

In the Cavite area, fresh fish are arranged on bamboo trays and partially sun-dried to help firm up the fish during brine cooking. In Mercedes, however, the surface drying of fish was carried out after brine cooking; partial drying is not practised in the smoking method used at Navotas.

### Brining

In Mercedes and Navotas the fish are soaked in a saturated brine solution prior to weak-brine cooking. In Cavite, the fish are cooked directly in saturated brine. Absorption of salt takes place during cooking and the fish are washed to remove excess salt prior to smoking.

### Smoking

Hot smoking is the common practice in all areas. The smoking ovens usually have an internal temperature of 70 to 100°C. In Mercedes and Navotas, the fish are smoked for 1 to 2 hours or until the desired golden brown colour is obtained. In Cavite, the fish are smoked for only 30 to 45 minutes but this is enough to impart a smoked flavour and brownish appearance.

### Packing and storing of smoked fish

In all areas, smoked fish products are arranged in bamboo baskets lined with paper or banana leaves. Smoked products from Mercedes have the most salty and smoky flavour and are more glossy than those from Navotas; both products are dry and tough. The Cavite product is shiny, moist and juicy.

During the peak season in Mercedes, the fish are processed in bulk, placed in cold storage, taken out and sold in the market. In Navotas, the fish are cooked in bulk in rattan baskets, placed in cold storage and smoked only when the supply of fresh fish is scarce. The Cavite processors, however, cannot take advantage of abundant supplies due to the lack of cold storage facilities.

### *Chemical and microbiological evaluation of roundscad*

#### During processing

The results of chemical and microbiological analyses of roundscad during processing are summarized in Table 1. In all cases the moisture content of fish flesh decreased and the salt content increased as processing proceeded. The smoked fish products from Mercedes and Navotas contained 12 to 13 percent water-phase salt content while those of Cavite had 4.5 percent only. A high waterphase salt content is desirable to retard bacterial spoilage.

There was no specific trend in the TVN values. The fish were still acceptable at TVN values of 30 mg N/100 g of sample. The smoked samples from Cavite had relatively high TVN values and high microbial counts.

The microbial count, in general, decreased as processing continued. Fresh fish from Mercedes had a log count/g of 5.34 but this decreased to 2.47 in the smoked product. The fish from Cavite had a log count/g of 5.52 which dropped to 5.03 after cooking, then increased abruptly after smoking. These high counts could be attributed to the poor quality of the raw materials used or to improper handling and poor sanitation during processing. Most of the bacteria isolated were Gram-positive cocci and *Bacillus* spp.

Brining has a selective action on the fish flora; suppressing, to some extent, the *Pseudomonas* spp., which are considered to be most active spoilage bacteria, but allowing the coryneforms and *Micrococcus* spp. to predominate. Zaki *et al.* (1976) found that total plate counts on Nile boliti (*Tilapia nilotica*) decreased and that coli-forms (which were present in the fresh fish) were absent with increased brining time.

#### During storage

The smoked samples were monitored daily for chemical and microbiological changes and the results are given in Table 2. The smoking procedures affect the stability of the product as shown in the TVN, TMA, TBA and microbial counts during storage. The smoked fish from Cavite were edible only for three days; on the fourth

day they were already slimy, mouldy and putrid. The TVN, TMA, TBA and microbial counts of the products at this stage were relatively high compared to those from Navotas and Mercedes.

The smoked fish from Navotas became mouldy after 5 days and were discarded. The TBA values were high; this may be due to fat oxidation which occurred during frozen storage (for several weeks) of the cooked fish before smoking. Yu and Sinnhuber (1968) reported that canned and frozen fish of good quality had TBA values of less than 3 while products of poorer quality had TBA values from 4 to 27. Although the smoked fish had TBA values as high as 28, the rancid taste in the fish was not strong. These high TBA values may indicate that the raw material was of poor quality.

The samples from Mercedes were spoiled after seven days because of thick mould growth. The TMA, TVN and TBA values increased only slightly during storage. Seasonal variation of the trimethylamine oxide contents and variability in the proportion of organisms able to reduce trimethylamine oxide affect the production of TMA (Woolen, 1970).

The predominant bacteria in smoked samples from Navotas were *Micrococcus* spp. while those from Cavite were *Bacillus* spp. Hot smoked fish may reach a temperature of 65-75°C for 20 minutes or more and the more resistant mesophiles and spore formers will still survive.

Table 1

Chemical and microbiological analyses of roundscad during processing

Area	Stage of processing	Moisture (%)	Salt (%)	Water-phase salt (%)	TVN (mg N/100 g)	Log count (per g)
Mercedes	Fresh	73.35	0.75	1.01	30.49	5.34
	After brine-soaking	68.75	2.90	4.05	29.75	5.85
	After drying	NA	NA	NA	NA	NA
	After brine-cooking	5.20	4.05	6.50	31.94	3.93
	After drying	55.40	5.75	9.40	32.20	3.42
	After smoking	48.10	7.03	12.75	33.60	2.47
Cavite	Fresh	73.11	0.58	0.78	33.41	5.52
	After brine-soaking	NA	NA	NA	NA	NA
	After drying	68.43	1.02	1.47	36.45	5.03
	After brine-cooking	68.37	2.05	2.91	30.38	2.90
	After drying	NA	NA	NA	NA	NA
	After smoking	65.25	3.08	4.50	42.53	6.52
Navotas	Fresh	72.30	0.78	1.07	26.70	—
	After brine-soaking	65.70	2.50	3.67	22.30	—
	After drying	NA	NA	NA	NA	NA
	After brine-cooking	51.50	5.61	9.82	18.87	6.55
	After drying	NA	NA	NA	NA	NA
	After smoking	49.50	6.85	12.15	18.15	2.47

NA = applicable

Table 2

Chemical and microbiological analyses of smoked roundscad during storage

Area	Days' storage	TVN (mg N/ 100 g)	TMA (mg N/ 100 g)	TBA (mg malon- aldehyde/kg)	Log count (per g)
Mercedes	1	33.60	8.70	15.55	—
	2	35.40	7.50	15.55	—
	3	29.70	9.26	18.14	6.97
	4	30.10	10.08	15.55	—
	5	27.81	8.50	23.04	—
	6	31.80	10.82	26.40	—
	7	36.37	15.96	30.03	—
Cavite	1	42.53	17.20	10.00	6.52
	2	45.57	19.18	14.00	7.60
	3	54.68	20.28	15.70	8.40
Navotas	1	18.15	19.49	26.41	2.47
	2	21.78	16.04	21.89	6.22
	3	23.23	20.72	24.74	7.36
	4	31.87	20.30	25.70	7.85
	5	48.03	22.48	28.67	8.32

*Acceptability of smoked products*

The processors claim that the method of smoking is dictated by the consumers' preference. Cavite processors supply smoked fish to some parts of Manila, Rizal, Batangas and Laguna where people prefer tender, juicy but not salty smoked fish. People on the northern part of Luzon and some parts of Manila are said to like tender, juicy and salty smoked fish. This group is supplied by Navotas processors. Mercedes supplies the whole of the Bicol region, where the preference is for salty and slightly tough, smoked fish.

Differences in consumer preference were tested by conducting a sensory evaluation on a 9-point hedonic scale; 15 panellists from different regions of the country took part. The species tested were freshwater milkfish, brackish-water milkfish, Indian sardines, roundscad and fimbriated herring. The mean scores of the 15 panellists are give in Table 3.

Table 3

Acceptability of different species of fish processed by 3 methods of smoking

Species	Mercedes	Cavite	Navotas	Mean <sup>1/</sup>
Roundscad	6.71	6.85	6.69	6.75 <sup>a</sup>
Fimbriated herring	5.43	6.71	6.57	6.24 <sup>ab</sup>
Freshwater milkfish	6.12	6.43	6.29	6.28 <sup>ab</sup>
Indian sardines	6.00	5.76	6.15	5.97 <sup>b</sup>
Brackish-water milkfish	5.68	5.43	5.86	5.62 <sup>c</sup>

1/ There is a significant difference (at 5% level) between means with different superscripts

Analysis of variance showed that acceptability is affected by the species of fish (at 5 percent level of probability). Different individuals have species preferences for smoked fish but the methods tested all produced smoked fish that are equally acceptable.

## RECOMMENDATIONS

### *Alternative methods of smoking*

As a result of these studies, the authors propose improvements in smoking procedures shown in Figs. 4, 5 and 6. These improvements could help to minimize handling, improve sanitation and take into account species, size and fat content of the fish. The proposals are still theoretical, however, and further experimentation is required.

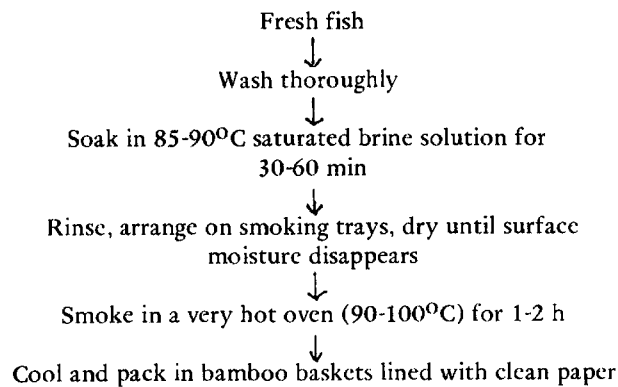


Figure 4. Suggested method for smoking fish 20 cm or less in length

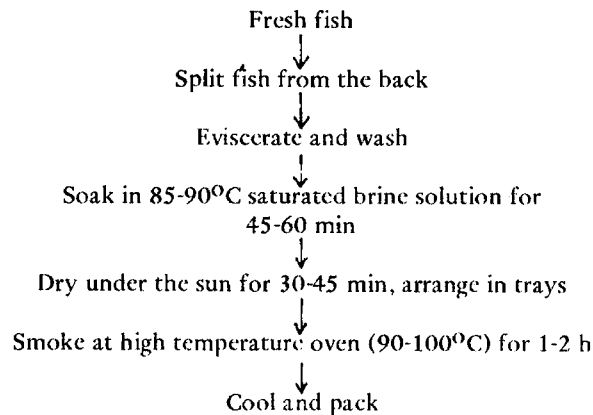


Figure 5. Suggested method for smoking fatty fish more than 20 cm in length

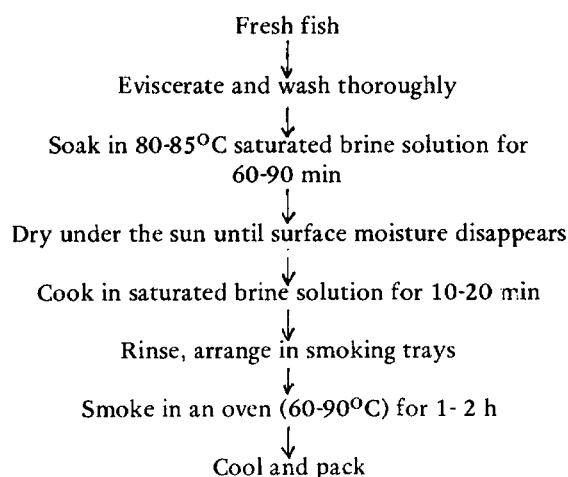


Figure 6. Suggested method of smoking of lean fish more than 20 cm in length

The recommended process for small species (Fig. 4) produces a product, with 8 to 10 percent salt and 50 to 55 percent moisture, which will be stable for 6 to 8 days at room temperature.

For larger species of fish which are fatty (5.7 percent or more fat) the procedure is described in Fig. 5. The fresh fish must be split from the back to facilitate evisceration and to give a higher surface to volume ratio for easy drying.

Figure 6 shows the recommended procedure for lean and large fish. It follows closely the Cavite procedure except that the fish undergo brine-soaking to increase salt absorption. For very large, thick fish, the cooking time must be increased to about 20 to 30 minutes. Smoking can then be carried out in a relatively cool oven.

#### *Improved methods of handling and storing of smoked fish*

Moisture and salt content play an important role in prolonging the shelf-life of smoked fish. Optimum levels of 40 to 50 percent moisture and 6 to 9 percent salt will aid in controlling moulds and prolonging shelf-life. The addition of sorbic acid or potassium sorbate before smoking could also inhibit the mould growth. Rancidity can be inhibited by adding antioxidants such as BHA and BHT. According to Sankaran (1976), BHA was effective in completely inhibiting bacterial growth and the sporulation of toxigenic fungi such as *Aspergillus flavus* and *Aspergillus fumigatus*.

Improper handling and poor sanitation promote rapid deterioration of smoked fish. Minimal handling of the smoked fish should be observed, regular changes of the brine solution, cleaning of trays and the control of flies are also highly recommended.



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## APPENDIX

Name \_\_\_\_\_

Date \_\_\_\_\_

## Scorecard for Sensory Evaluation of Smoked

*Roundskad*

Evaluate the quality attributes of the samples according to the rating scales below. Record results in the table. Please write any additional comments about any or all the samples in the back page.

Sample no	Colour	Texture	Saltiness	Smoke flavour	Flavour	General acceptability

*Colour, saltiness, smoke flavour*

- 7 very excessive
- 6 moderately excessive
- 5 slightly excessive
- 4 just right
- 3 moderately perceptible
- 2 slightly perceptible
- 1 imperceptible

*Texture*

- 7 very tough
- 6 tough
- 5 very firm
- 4 firm
- 3 soft
- 2 very soft
- 1 mushy

*General acceptability*

- 9 like extremely
- 8 like very much
- 7 like moderately
- 6 like slightly
- 5 neither like nor dislike
- 4 dislike slightly
- 3 dislike moderately
- 2 dislike very much
- 1 dislike extremely