Microbial Quality of Fish in Retail Trade in Cochin

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Microbial quality of fresh and frozen fish in retail trade in Cochin is presented. 49.4% of the fresh fish and 4.7% of the frozen fish samples examined had total plate counts more than 5.0×10^6 g^{-1}. *Escherichia coli* was detected in 89.8% of the fresh fish and 86.6% of the frozen fish, and their numbers were more than 20 g^{-1} in 78.2 and 21.2% of the samples respectively. Faecal streptococci were detected in all the fresh fish and 87.4% of the frozen fish and their numbers were more than 1000 g^{-1} in 60.3 and 11% of the samples respectively. Salmonella was detected in 5.8 and 8.7% of the fresh and frozen fish samples respectively.

Cochin is a major fish landing centre on the west coast of India and fishes from other landing centres are also brought to Cochin for retail trade. Major part of the fish, other than prawns, brought to Cochin are sold in the retail markets. A few selected species of fishes are frozen and sold through the retail cold storages. While inspection and quality control measures are available for fish and fishery products meant for export, no such control exists for fish sold in the retail markets. Fish of very poor quality, and even contaminated with pathogenic organisms are also sold in the markets. This can pose serious health hazards to the consumers unless timely and proper care is taken.

Most of the studies so far carried out have been on the quality of fish and fishery products meant for export (Pillai *et al.*, 1965; Iyer & Chaudhuri, 1966; Iyer *et al.*, 1966; Sreenivasan & Joseph, 1966; Pillai & Rao, 1969; Mathen *et al.*, 1975). Many reports are available on the quality of cured fish in different parts of the country (George Joseph *et al.*, 1983, 1986, 1988; Kalaimani *et al.*, 1988; Valsan *et al.*, 1985). Iyer *et al.* (1986a) have reported on the quality of fresh fish in retail markets of Bombay. Iyer *et al.* (1986b) and Damle *et al.* (1986) have reported on the quality of fish preparations in domestic trade. Varma *et al.* (1988) have reported on the quality of commercially frozen boiled clam meat. Studies carried out on the bacteriological aspects of fishes have been mainly on the incidence of specific pathogenic organisms (Sanjeev *et al.*, 1986; Lalitha & Iyer, 1986; Iyer & Srivastava, 1988, 1989). Lakshmanan *et al.* (1984) have reported on the quality of fish landed at the Cochin Fisheries Harbour. So far no systematic studies have been carried out on the bacteriology of fish in retail trade in Cochin, and hence this study was taken up during 1985–'87 to assess the load of different bacteria and the incidence of faecal indicator and pathogenic organisms in fresh and frozen fish available in the retail markets in Cochin.

Materials and Methods

Samples of fresh fish belonging to different species were collected at regular intervals from the retail markets in Cochin. Frozen fish samples were collected from the cold

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storage in Cochin. The samples were brought to the laboratory under aseptic conditions and were analysed immediately. Total plate count, counts of faecal streptococci and coagulase positive staphylococci were determined as per IS: 2237 (1971). *E. coli* was enumerated by a 3-Tube MPN technique using Mac Conkey broth followed by gas production in brilliant green bile broth and indole production at 44 ± 0.5°C (Harrigan & Mc Cance, 1976). Salmonella was detected by AOAC (1975) method.

Results and Discussion

A total of 156 fresh fish samples belonging to 24 different species were analysed. The names and number of samples of each of the 10 major species are presented in the tables, and the remaining minor species have been grouped under the head miscellaneous.

The total plate counts of the fresh fish samples are presented in Table 1. The lowest total plate count obtained was 7.0×10^3 g^{-1} in a sample of sardines and the highest was 3.1×10^7 g^{-1} in a sample of jew fish. Lakshmanan *et al.* (1984) have reported that 66.7% of the fish collected from landing centres in Cochin had total plate counts more than 1.0×10^5 g^{-1} and only 8.5% had counts more than 5.0×10^5 g^{-1}. In the present study, 69.9% of the samples had total plate counts more than 1.0×10^5 g^{-1}. and 49.4%

Table 1. *Total plate counts of fresh fish*

Fish	No. of samples	Total plate count, g^{-1} Range	Percentage of samples showing total plate counts, g^{-1}			
			Less than 5.0×10^5	More than 5.0×10^5	More than 1.0×10^6	More than 1.0×10^7
Grey mullet *(Mugil cephalus)*	24	1.01×10^4 to 1.0×10^7	37.5	62.5	41.7	4.1
Sardine *(Sardinella longiceps)*	20	7.0×10^3 to 1.0×10^7	80.0	20.0	10.0	10.0
Jew fish *(Johnius dussumieri)*	20	1.0×10^4 to 3.1×10^7	20.0	80.0	55.0	15.0
Tilapia *(Tilapia mossambica)*	18	3.7×10^4 to 2.4×10^7	38.9	61.1	44.4	5.6
Mackerel *(Rastrelliger kanagurta)*	16	1.0×10^4 to 2.22×10^6	75.0	25.0	12.5	0
Kilimeen *(Nemipterus japonicus)*	11	1.0×10^4 to 6.0×10^6	63.6	36.4	27.3	0
Pallikora *(Otolithus argentius)*	8	5.1×10^4 to 4.8×10^6	62.5	37.5	37.5	0
Lactarius *(Lactarius lactarius)*	5	1.0×10^4 to 1.9×10^7	20.0	80.0	40.0	20.0
Indian whiting *(Sillago sihama)*	5	1.7×10^6 to 1.5×10^7	0	100.0	80.0	20.0
Gizzard shad *(Anodontostoma chacunda)*	5	5.6×10^4 to 1.1×10^6	40.0	60.0	20.0	0
Miscellaneous	24	7.0×10^3 to 6.0×10^6	66.7	33.3	25.0	0
Total	156	7.0×10^3 to 3.1×10^7	50.6	49.4	33.3	5.2

had counts more than 5.0×10^5 g^{-1}. According to the existing standards for fresh fish (IS: 4780 & 4781, 1978) a total plate count of upto 5.0×10^5 g^{-1} is considered as acceptable. At this level only 50.6% of the samples could be considered as acceptable. Iyer *et al.* (1986a) have observed that 74.4% of the samples collected from retail markets in Bombay had total plate counts less than 1.0×10^6 g^{-1} and could be considered as acceptable based on other parameters. Even at this level only 61.5% of the samples from retail markets in Cochin could be considered as acceptabe. The high total plate counts in samples from retail markets is an indication of the poor hygienic standards of the markets.

The distribution of *E. coli* and faecal streptococci, the two major faecal indicator organisms, in fresh fish from retail markets are presented in Tables 2 and 3. 10.2% of the samples were free from *E. coli*, whereas none of the samples were free from faecal streptococci. The highest count of *E. coli* observed was 1.3×10^5 g^{-1} in one sample of pallikora *(Otolithus argentius)*. The lowest count of faecal streptococci was 38 g^{-1} in sardines and the highest was 8.3×10^4 g^{-1} in a miscellaneous fish. 11.6% of the samples showed *E. coli* counts less than 20 g^{-1} and 78.2% showed counts more than 20 g^{-1} 63.5% of the samples showed *E. coli* counts more than 100 g^{-1}, 35.9% more than 100 g^{-1} and 11.6% more than 10,000 g^{-1}. Generally samples having *E. coli* counts more than 20 g^{-1} and faecal streptococci counts more than 1000 g^{-1} are considered as unacceptable (IS: 6032, 1971, Iyer *et al.*, 1973, 1986a). Accordingly only 21.8% and 39.7% of the samples could be considered as acceptable based on counts of *E. coli* and faecal streptococci, respectively. Lakshmanan *et al.* (1984) have observed that 63.2% of the samples from landing centres were free from *E. coli* and only 26.4% of the samples had counts more than 20 g^{-1}. Also 20.4% of the samples had counts of faecal streptococci more than 1000 g^{-1}. Iyer *et al.* (1986a) have reported that 74.2% of the samples from retail markets in Bombay had *E. coli* counts less than 20 g^{-1}, and 60.6% of the

Table 2. *Distribution of E. coli in Fresh fish*

Fish	No. of samples	Most probable number *E. coli*, g^{-1} Range	Percentage of samples showing MPN of *E. coli*,g^{-1} Nil	Less than 20	More than 20	More than 1,000	More than 10,000
Grey mullet	24	0 to 3.4×10^4	16.7	4.1	79.2	45.8	20.8
Sardine	20	1.1 to 8.6×10^3	0	35.0	65.0	10.0	0
Jew fish	20	0 to 8.4×10^4	15.0	5.0	80.0	45.0	15.0
Tilapia	18	0 to 2.7×10^4	5.6	5.6	88.8	55.5	11.1
Mackerel	16	1.6 to 1.9×10^3	0	18.7	81.3	12.5	0
Kilimeen	11	0 to 3.7×10^4	9.1	0	90.9	63.6	18.2
Pallikora	8	80 to 1.3×10^5	0	0	100.0	50.0	12.5
Lactarius	5	0 to 6.4×10^3	20.0	0	80.0	60.0	0
Indian whiting	5	1.4×10^3 to $3.1\ 10^4$	0	0	100.0	100.0	60.0
Gizzard shad	5	1.2 to 4.0×10^2	0	40.0	60.0	0	0
Miscellaneous	24	0 to 2.3×10^4	25.0	12.5	62.5	12.5	8.3
Total	156	0 to 1.3×10^5	10.2	11.6	78.2	35.9	11.6

Table 3. *Distribution of faecal streptococci in fresh fish*

Fish	No. of samples	Count of faecal streptococci, g^{-1} Range	Percentage of samples showing counts, g^{-1} Less than 1000	More than 1000	More than 5000	More than 10000
Grey mullet	24	80 to 5.0×10^4	33.3	66.7	33.4	16.7
Sardine	20	38 to 1.3×10^4	45.0	55.0	25.0	10.0
Jew fish	20	70 to 1.4×10^4	35.0	65.0	35.0	15.0
Tilapia	18	1.8×10^2 to 2.0×10^4	44.5	55.5	44.5	22.2
Mackerel	16	40 to 4.0×10^4	62.5	37.5	18.7	6.2
Kilimeen	11	60 to 1.7×10^4	27.3	72.7	36.3	9.1
Pallikora	8	2.34×10^2 to 3.0×10^4	25.0	75.0	37.5	12.5
Lactarius	5	1.0×10^2 to 1.3×10^4	20.0	80.0	20.0	20.0
Indian whiting	5	1.1×10^3 to 6.1×10^4	0	100.0	80.0	40.0
Gizzard shad	5	1.1×10^2 to 1.2×10^4	20.0	80.0	20.0	20.0
Miscellaneous	24	69 to 8.3×10^4	54.2	45.8	25.0	12.5
Total	156	38 to 8.3×10^4	39.7	60.3	32.8	14.7

samples had faecal streptococci counts less than 1000 g^{-1}. In comparison with these findings, the samples from retail markets in Cochin were very heavily contaminated with faecal indicator organisms. This observation requires serious consideration, especially in view of the fact that Rao & Gupta (1978) have reported the incidence of enteropathogenic *E. coli* in marine fishes. The presence of very large numbers of faecal indicator organisms in fishes gives an indication of the level of contamination with faecal matter and the possibility of other pathogenic micro-organisms being present.

The incidence of salmonella in various fish samples is shown in Table 4. 5.8% of the samples were found to be contaminated with salmonella and the incidence was maximum in grey mullet and pallikora (12.5% each), followed by tilapia (11.1%), sardines (10.0%) and kilimeen (9.1%). Salmonella was not detected in jew fish mackerel, lactarius, Indian whiting, gizzard shad and the miscellaneous fishes. Lakshmanan *et al.* (1984) did not detect salmonella in any of the samples from the landing centre and Iyer *et al.* (1986a) detected salmonella in only 4.4% of the samples from retail markets

Table 4. *Occurrence of salmonella in fresh fish*

Fish	No. of samples	Samples showing salmonella Number	%
Grey mullet	24	3	12.5
Sardine	20	2	10.0
Jew fish	20	0	0
Tilapia	18	2	11.1
Mackerel	16	0	0
Kilimeen	11	1	9.1
Pallikora	8	1	12.5
Lactarius	5	0	0
Indian whiting	5	0	0
Gizzard shad	5	0	0
Miscellaneous	24	0	0
Total	156	9	5.8

Table 5. *Total plate counts of frozen fish*

Fish	No. of samples	Total plate count, g^{-1} Range	Percentage of samples showing total plate counts, g^{-1}				
			Less than 1×10^3	Less than 1×10^5	Less than 5.0×10^5	More than 5.0×10^5	More than 1×10^6
Pearl spot *(Etroplus suratensis)*	28	2.25×10^5 to 4.0×10^6	0	82.1	92.0	7.2	3.6
Seer *(Scomberomorus guttatus)*	26	3.61×10^2 to 1.23×10^3	15.4	80.8	100.0	0	0
Black pomfret *(Parastromateus niger)*	23	3.47×10^2 to 6.27×10^5	4.3	60.9	95.7	4.3	0
Silver pomfret *(Pampus argentius)*	18	4.01×10^3 to 6.29×10^5	0	77.8	94.5	5.5	0
Red snapper *(Lutianus argentimaculatus)*	12	3.26×10^2 to 8.07×10^4	8.3	100.0	100	0	0
Russels scad *(Decapterus russelli)*	10	4.40×10^3 to 5.55×10^5	0	80.0	90.0	10.0	0
Miscellaneous	10	1.45×10^2 to 3.96×10^6	10.0	80.0	90.0	10.0	10.0
Total	127	1.45×10^2 to 4.0×10^6	5.5	81.9	95.3	4.7	1.6

Table 6. *Distribution of E. coli in frozen fish*

Fish	No. of samples	Most probable number of *E. coli*, g^{-1} Range	Percentage of samples showing MPN of *E. coli*, g^{-1}				
			Nil	Less than 20	More than 20	More than 100	More than 1000
Pearl spot	28	0 to 1.12×10^4	7.1	57.2	35.7	21.4	7.1
Seer	26	0 to 25	42.3	50.0	7.7	0	0
Black pomfret	23	0 to 8.5×10^2	8.7	56.5	34.8	13.1	0
Silver pomfret	18	0.33 to 1.18×10^3	0	89.0	11	5.5	5.5
Red snapper	12	0 to 6.66	16.7	83.3	0	0	0
Russels scad	10	1.12 to 94	0	70.0	30.0	0	0
Miscellaneous	10	0.56 to 88	0	80.0	20.0	0	0
Total	127	0 to 1.12×10^4	13.4	65.4	21.2	7.8	2.4

of Bombay. The incidence of salmonella in 5.8% of the samples from retail markets in Cochin is to be expected considering the level of contamination of the samples with faecal indicator organisms.

Considering all the bacteriological parameters like total plate count, counts of faecal indicator organisms and incidence of salmonella, the fresh fish samples in retail markets in Cochin are of inferior quality

when compared with those in Bombay markets as reported by Iyer *et al.* (1986a). The fish get heavily contaminated with micro-organisms due to the poor and unhygienic handling practices. It is also evident that most of the contamination takes place in the markets or during transport from the landing centres to the market since majority of the samples from the landing centres were free from such contamination as reported by Lakshmanan *et al.* (1984). The presence of very large numbers of faecal indicator organisms in the fishes is an indication of contamination from faecal matter. Even-though salmonella was detected in only 5.8% of the samples, there are chances that more samples were contaminated with salmonella or other human pathogens which might have escaped detection.

Great care has to be taken to prevent such contamination and also to avoid cross contamination of other food items. Cross contamination of other food items which are not subjected to heat processing can cause serious health hazards. IS: 8082 (1976) has specified basic requirements for a fish market, but very little attention is given to implement it. Immediate steps have to be taken to implement the minimum prescribed standards for fish markets and also to formulate and implement quality standards for all fishes sold in the retail markets.

A total number of 126 frozen fish samples belonging to 9 different species collected from different cold storages in Cochin were analysed. The names and number of samples of each of the six major species are presented in the Tables, and the remaining 10 samples belonging to three minor species are grouped under the head miscellaneous.

The total plate counts of the frozen fish samples are presented in Table 5. The total plate counts ranged from 1.45×10^2 to 4.0×10^6 g^{-1} and the lowest count was observed in a miscellaneous fish and the highest in pearl spot. In 5.5% of the samples the total plate counts were less than 1.0×10^3 g^{-1}. 81.9% of the total samples showed total plate counts less than 1.0×10^6 g^{-1} and 4.7% of the total samples showed counts more than 5.0×10^5 g^{-1} and 1.6% had counts more than 1.0×10^6 g^{-1}. According to the existing standards for frozen fishery products for export (Dhamija, 1983) samples with total plate counts more than

Table 7. *Distribution on faecal streptococci in frozen fish*

Fish	No. of samples	Counts of faecal streptococci, g^1 Range	Percentage of samples showing counts, g^1			
			Nil	Less than 100	Less than 1000	More than 1000
Pearl spot	28	0 to 9.70×10^3	10.7	28.6	64.3	25.0
Seer	26	0 to 6.17×10^2	34.6	42.3	65.4	0
Black pomfret	23	0 to 1.18×10^3	4.3	21.7	86.9	8.8
Silver pomfret	18	0 to 4.12×10^3	5.5	16.7	83.5	11.0
Red snapper	12	0 to 3.92×10^2	8.3	75.0	91.7	0
Russels scad	10	0 to 1.84×10^3	10.0	10.0	70.0	20.0
Miscellaneous	10	61 to 9.32×10^3	0	20.0	90.0	10.0
Total	127	0 to 9.70×10^3	12.6	30.7	76.4	11.0

5.0×10^5 g^{-1} are considered unacceptable. At this level, only 4.7% of the frozen fish samples could be considered unacceptable. This included 7.2% of pearl spot, 5.5% of silver pomfret, 4.3% of black pomfret, 10.0% of russels scad and 10.0% of the miscellaneous fish. Based on total plate counts, the quality of frozen fish samples from retail outlets could be considered as good.

The distribution of *E. coli* and faecal streptococci in frozen fish samples is given in Tables 6 and 7. 13.4% of the samples were free from *E. coli* and 12.6% were free from faecal streptococci. The highest counts for *E. coli* and faecal streptococci were 1.12×10^4 and 9.7×10^3 g^{-1} respectively in pearl spot samples. 21.2% of the samples showed *E. coli* counts more than 20 g^{-1} and 7.8% of the samples showed *E. coli* counts more than 100 g^{-1}. 2.4% of the samples showed *E. coli* counts more than 1000 g^{-1}. In the case of faecal streptococci, 11.0% of the samples showed counts more than 1000 g^{-1}. Pearl spot samples showed higher counts both of *E. coli* and faecal streptococci. This may be due to the brackish water habitat of pearl spot. According to the standards specified for frozen fish (Dhamija, 1983, Iyer *et al.*, 1973) samples having more than 20 g^{-1} *E. coli* and 1000 g^{-1} faecal streptococci are unacceptable. As per these standards 78.8% of the frozen fish samples could be considered as acceptable based on *E. coli* counts and 89.0% of the samples based on faecal streptococci counts.

Coagulase positive staphylococci were not detected in 91.3% of the samples and in 8.7% of the samples where they were detected, the counts were always less than 100 g^{-1}, the prescribed limit of acceptability (Dhamija, 1983). Iyer & Srivastava (1988) have reported that coagulase positive staphylococci is not a problem in frozen fishery products processed in this country. Sanjeev *et al.* (1986) have reported the incidence of enterotoxigenic staphylococci in frozen prawns and crab meat. In the present study, coagulase positive staphylococci were detected in very few samples and that too well within the stipulated limits.

The incidence of salmonella in various frozen fish samples is presented in Table 8. Salmonella was detected in 8.7% of the total samples and the incidence was more in pearl spot (14.3%) followed by black pomfret (13.0%), seer (7.7%), silver pomfret 5.6%) and in one horse mackerel. Iyer & Srivastava (1989) have reported the incidence of salmonella in frozen fish samples like seer, cat fish red snapper etc. The presence of salmonella in frozen fish is an indication of external contamination. Iyer & Srivastava (1989) have reported that salmonella strains could resist freezing and frozen storage. As such the detection of salmonella in frozen fish poses serious health hazards by way of cross contamination of other food items. The frozen fish samples, in general, were found to be of good quality except for the incidence of salmonella in some samples.

Table 8. *Occurrence of salmonella in frozen fish*

Fish	No. of samples	Samples showing salmonella	
		Number	Percentage
Pearl spot	28	4	14.3
Seer	26	2	7.7
Black pomfret	23	3	13.0
Silver pomfret	18	1	5.6
Red snapper	12	0	0
Russels scad	10	0	0
Miscellaneous	10	1	10.0
Total	127	11	8.7

The results of this study indicates that the fishes sold in the retail markets in Cochin are very heavily contaminated with faecal indicator organisms and some of them are even contaminated with pathogenic organisms like salmonella. This is mainly due to the unhygienic handling practices, and has to be viewed seriously because of the probable health hazards. It is very essential to formulate and implement quality standards for fish and fishery products meant for internal markets.

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