Sri Lanka J. Aquat. Sci. 5 (2000): 97-104

Investigations on quality aspects of tuna catches of multi-day boats at the Negombo fish landing site, in Sri Lanka

G J GANEGAMA ARACHCHI[1*], K G C ARIYADASA[2], W M K PERERA[3], and J M P K JAYASINGHE[1]

[1]Institute of Post Harvest Technology, National Aquatic Resources Research and Development Agency (NARA), Crow Island, Colombo 15, Sri Lanka

[2]Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka

[3]Department of Nutrition and Community Resources Management, Wayamba University, Kuliyapitiya, Sri Lanka

*Corresponding Author: (E-mail: geevika@nara.ac.lk)

Abstract

Quality of the fish produced is becoming increasingly important in national and international fish trade. Multi-day boats (MDB) contribute around 60,000 mt annually to the total fish landings in Sri Lanka. However, there has been no scientific investigation on the quality of fish landed from these boats. The present study concentrates on the microbiological and biochemical quality of skinned skipjack tuna in the boats, jetty and initial retail stage in the market. Aerobic plate counts (APC) were in the range of 10^4-10^6 colony forming units per gram (cfu g^{-1}). Histamine producing bacterial counts (HPBC) of fish were 560 cfu g^{-1} in boat, 820 cfu g^{-1} in jetty and 2200 cfu g^{-1} in initial retail stage. Higher HPBC were observed in samples from market compared to those from boat or jetty. Hydrogen sulfide producing bacterial counts (HSPBC) in fish, were 670 cfu g^{-1} in boat, 1450 cfu g^{-1} in jetty and 2690 cfu g^{-1} in initial retail stage. In 92% of fish, feacal coliform was present and ranged from <3 to 1100 Most Probable Number (MPN g^{-1}). *Escherichia coli* were detected in 68% of samples and ranged from <3 to 21 MPN g^{-1}. Trimethylamine (TMA) and total volatile base (TVB) contents of fish ranged from 3.21 to 21.03 mg $100g^{-1}$ and from 6.32 to 38.53 mg 100 g^{-1} respectively along the three stages. TVB contents of fish were significantly higher during the third stage of commercial channel than in the boat. Samples of ice used in fishing trips, sea water at landing area, ice used in fish hold and bilges of boats were found to be heavily contaminated with fecal coliform and *E.coli*. APC ranged from 10^5 to 10^8 cfu ml^{-1} in crushed/flake ice and in water used in the process. All ice and water samples were not in accordance with the Sri Lanka Standards 614(1983) and 971(1992) for microbiological quality.

Introduction

Quality of the fish produced is becoming increasingly important in national and international fish trade. Quality of fish in fishing day boats in different landing sites of Sri Lanka has been recorded to be within the acceptable range and the aerobic plate count (APC) of fish at the landing sites along the southern coast of Sri Lanka was found to range from 10^2 to 10^4 cfu g^{-1} (Jayaweera *et al.* 1988).

There has been no literature on handling practices and quality of fish from the multi-day boats (MDBs) in Sri Lanka. At present, offshore fishery contributes for 65% of the annual total production of fish in Sri Lanka. Total offshore fishery production was 73,240 mt in 1998. Tuna fishery has become the major fishery from MDB, contributing around 57% to the total offshore fish production (Anon. 1999).

A major portion of tuna that comes from MDB is landed at Negombo. Fleet size of MDB in Negombo in 1996 was 198 (Anon. 1996). Handling practices of fish at Negombo landing site has been observed to be very poor (Hemantha & Amarasinghe 1994). Overloaded shelves, higher storage temperatures and long durations of the fishing trips have been observed. The harbour water, which does not conform to required sanitary standards, is used to clean the fish upon unloading from boats and in handling on the jetty (Hemantha & Amarasinghe 1994). Handling and preservation practices for MDB are still being developed in Sri Lanka.

As such, information on quality of fish from MDBs is necessary in developing strategies for better handling practices in order to provide a safe product for the consumers. Therefore, the present investigation was carried out to examine microbiological and biochemical quality of fresh fish available immediately after the unloading and in the market and to identify the sources of contamination of *E.coli*, if any.

Materials and methods

Sampling

The present study was conducted from April 1997 to October 1998. Field visits were made twice a month to the fish landing site at Negombo, and Skipjack tuna (*Katsuwonus pelamis*) from MDBs were sampled randomly. Each sample comprised of two fish. Ice used to store fish in the MDBs, bilge water retained in the boat, ice from the producing plants and sea water near the fish unloading site were also sampled aseptically. Samples were transported to the laboratory at NARA in less than five hours and were stored in ice in insulated boxes.

Microbiological and biochemical analysis of fish

In the laboratory, fish were skinned and homogenized with peptone buffer and serial dilutions (with peptone buffer) were prepared. APC were done for these serial dilutions on nutrient agar using spread plate method incubating at 30°C for 2-3 days. Hydrogen sulphide producing bacterial count (HSPBC) was done on peptone iron agar (Difco) using pour plate method incubating at 30°C for 2-3 days. Histamine producing bacterial count (HPBC) was done using Niven's media (Niven *et al.* 1981) on spread plates, incubating at 35°C for 2-3 days. Feacal coliform and *E.coli* were detected as MPN g^{-1} of sample according to Anon. (1992). Trimethylamine (TMA)

and total volatile bases (TVB) were measured in the composite skinned fish samples. using modified micro-diffusion method described by Beatty and Gibbons (1937).

Microbiological analysis of water and ice

APC. feacal coliform and *E.coli* counts were performed on ice obtained from ice plants. ice remaining after fishing trips. water at the landing site and bilge from fish unloading MDB. Standard plate count and Most Probable Number method for water samples described in Anon (1992) were used to enumerate APC and feacal contaminants.

Analysis of data

Examined quality parameters were analyzed and compared using General Linear Model and Least significant difference technique of mean separation in SAS software.

Results

Microbial profile of skinned fish

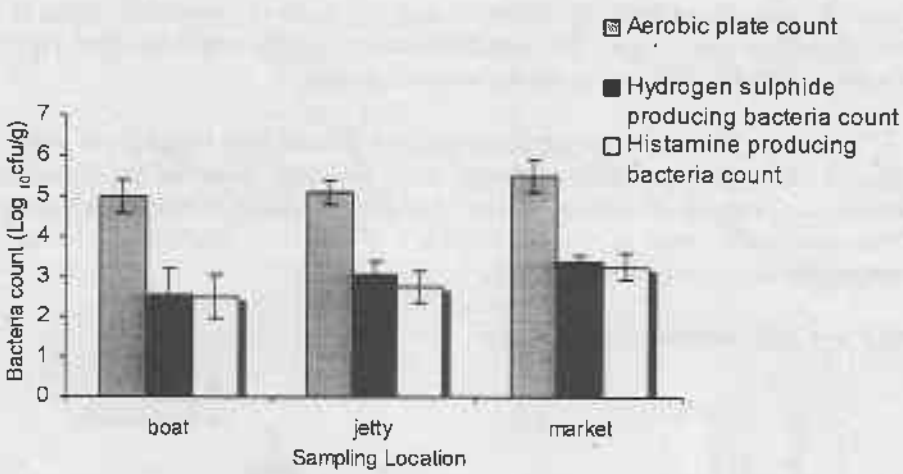

Figure 1 Mean values for aerobic plate count (APC), hydrogen sulfide producing bacterial count (HSPBC) and histamine producing bacterial count (HPB) of composite samples of skinned skipjack tuna in boat jetty and first retail market at Negombo from April 1997 to October 1998 (vertical bars indicate the standard errors).

APC. HSPBC and HPBC profiles of skinned fish from the boat. jetty and market are given in Figure 1. Counts were in the range of 10^4-10^6 cfu g^{-1}. Mean values for APC of skinned fish in boat. jetty and market were $1.5x\ 10^5$ cfu g^{-1}. $1.6x10^5$ $cfu^{-1}g$ and $4.4x10^5$ cfu g^{-1} respectively. These APC values were not significantly different from each other at 5% level. HSPBC were 670 cfu g^{-1}. 1450 cfu g^{-1} and 2700 $cfu^{-1}g$ in the flesh of fish from boats. jetty and the market respectively. At 5% level. these counts were not significantly different from each other. HPBC were 560 $cfu^{-1}g$. 820 cfu g^{-1}

and 2200 cfu g^{-1} in fish samples from boats, jetty and retail market respectively. Significantly higher HPBC were observed in the samples from market than those from the boat and jetty ($p < 0.05$).

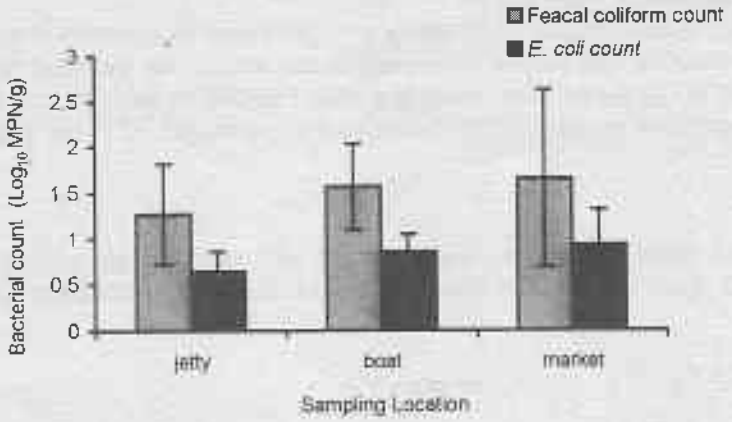

Figure 2. Mean values for feacal coliform and *E.coli* count of composite samples of skinned skipjack tuna in boat, jetty and retail market at Negombo from April 1997 to October 1998 (vertical bars indicate the standard errors).

Feacal coliform count and *E.coli* count of skinned fish samples are shown in Figure 2. An increasing order of counts along the three stages of the distribution channel was observed. In 92% of skinned fish samples, feacal coliform was recorded. These were in the range of 3 - 1100 MPN g^{-1}. *E. coli* were detected in 68% of the samples and ranged from 3 to 21 MPN g^{-1}.

TMA and TVN contents of skinned fish

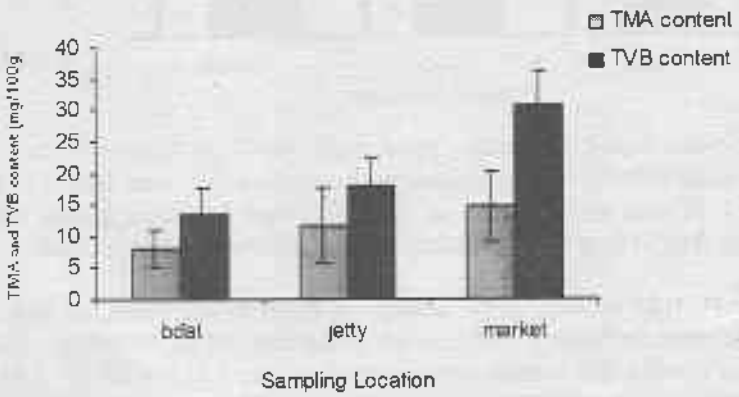

Figure 3. The mean values of TMA and TVB content of composite samples of skinned skipjack tuna in boat, jetty and retail market at Negombo from April 1997 to October 1998 (vertical bars indicate the standard errors).

The mean values of TMA and TVB contents of skinned fish in three stages of the commercial channel are shown in Figure 3. TVB contents of fish were significantly higher in the samples collected from the market than those from the boat and the jetty ($p < 0.05$).

Quality of ice and water

Table 1. Bacteriological quality of ice and water used in fish handling at the Negombo landing site from April 1997 to October 1998

Sample	Mean value for APC (cfu g^{-1})	Mean value for feacal coliform (MPN100ml^{-1})	Mean value for *E coli* (MPN 100m^{-1})
Water at landing site	6.67×10^{7}	>1600	32
Ice from factory	1.00×10^{8}	1297	14
Used ice	2.00×10^{8}	334	42
Bilge water	4.42×10^{8}	>1600	234

Samples of ice used in fishing boats recorded high feacal coliform and *E coli* counts (Table 1). Therefore, the ice used to preserve fish in fish holds of MDB is a potential source of *E. coli* contamination. Water near the jetty where the fish were unloaded from MDB was *E. coli* positive (Table 1). Bilges of the boats sampled were also found to be heavily contaminated with *E. coli*. APC ranged from 10^{7} to 1.9×10^{8} cfu ml^{-1} with a mean value of 1×10^{8} cfu g^{-1} in crushed/flake ice used in the fishery industry in Negombo.

Discussion

The APC counts of all the samples of skinned fish in the three locations were within the acceptable or marginal levels recommended by the International Commission on Microbial Specifications for Foods (ICMSF) (Huss 1994). ICMSF specifies the upper (rejectable) and lower (marginal) levels of acceptability as 1×10^{7} cfu g^{-1} and 5×10^{5} cfu g^{-1} respectively for APC in flesh of fish. Similar specification system for APC in fish from Newzealand standards has been given by Dorian *et al* (1992).

In 11% of samples of skinned fish, APC was $>5 \times 10^{5}$ cfu g^{-1} indicating a level of marginal acceptability. Balance of the fish were detected with acceptable APC

Nevertheless, in 79% of the samples APC values were in the range of $5x10^4$- $5x10^5$ cfu g^{-1} and these were closer to the marginally acceptable level. Higher APC in flesh of fish in initial stages of handling indicates that there is a potential for rapid spoilage along the commercial channels. Therefore, it is important to control the factors that influence the rapid proliferation of bacteria in fish in MDB and also during subsequent handling stages.

It has been reported that proper washing can significantly reduce the concentration of surface microflora (Lakshmanan *et al.* 1984). Use of clean melting ice on fish in handling and storing will make frequent washing of the fish in addition to the cooling effect. According to Huss (1994), hydrogen sulfide producing bacteria is one of the major groups which accounts for specific spoilage and spoilage is accelerated when HSPBC reaches a level of 10^7 cfu g^{-1}. HSPBC of 10^6 cfu g^{-1} is considered as a level of rejection (Barile *et al.* 1985). HPBC in tuna is also considered as an important quality aspect. Ahmed (1992) has reported on histamine poisoning associated with consumption of Scombroid fish such as tuna and mackerel. Both HSPBC and HPBC should not exceed 10^6 cfu g^{-1} in together or individually.

Presence of feacal coliform indicates the contamination of fish with feacal matter. *E. coli* has been detected in the range of 3-21 MPN g^{-1} in skinned fish. Although, some of the skinned tuna samples from MDB were not *E. coli* positive, it has been found that all non-skinned tuna from MDB collected in almost all landing sites in Southern Western coast of Sri Lanka, were *E. coli* positive (Ganegama Arachchi *et al.* 1999). Ahmed (1992) has shown that very low numbers of some feacal origin microbiological agents are sufficient to cause illness. Therefore, presence of *E. coli* in small numbers will be a risk when food safety is considered. Further, there are more chances for the presence of enteric infectious viruses in samples which are positive for fecal contaminations. Therefore, the presence of enteric infectious virus is also probable in feacal coliform and *E. coli* positive fish.

Marginally acceptable levels of TMA and TVB for fresh fish are 10-15 mg $100g^{-1}$ and 30-35 mg $100g^{-1}$ respectively (Huss 1988). 23% of the samples were found to be with unacceptable levels while 20% of the samples were found to be with marginally acceptable levels of TMA. The rest i.e. 57% were found to be with acceptable levels of TMA. Similarly, 11% of samples were found to have unacceptable levels of TVB while 4% of samples had marginally acceptable levels. Balance 85% was with an acceptable level of TVB.

Water at the landing site was also contaminated with feacal coliform and *E. coli* (Table 1). Harbour water is used to clean the fish when unload from MDB and during subsequent handling on the jetty. Water of potable quality is not available in the premises. This polluted water has the potential to contaminate the fish with feacal coliform and *E. coli*. This polluted water is used to clean the fish holds and none of the boats used sanitizers in preparing for the next fishing trip. This unsatisfactory cleaning of the fish hold may retain specific spoilage organisms and feacal contaminants which recontaminate the fish caught in the next trip.

All the ice and water samples analyzed did not comply with Sri Lanka Standards: 614:part 2 (SLSI 1983) and 971 (SLSI 1992) and EEC Directive for microbiological quality. Therefore, it is extremely necessary to make available clean ice and potable water with acceptable sanitary standards to the unloading center of

MDB in Negombo to ensure the maintenance of the microbial quality of landed fish within the accepted levels.

Acknowledgement

We are indebted to NARA management and to Professor M J S Wijeyaratne, the Dean of the faculty of science, University of Kelaniya for the encouraging and constructive comments.

References

Ahmed, F. E. 1992
Review: Assessing and managing risk due to consumption of sea food contaminated with microorganism, parasites and natural toxins in the US. International Journal of Food Science and Technology 27: 243-360

Anonymous 1992
Food and Drug Administration Bacteriological Analytical Manual (7th edition) AOAC International, Arlington, VA

Anonymous 1996
Fisheries Statistics (with statistics for the past six years). Data Management Unit, Ministry of Fisheries and Aquatic Resources, Maligawatte, Colombo 10, Sri Lanka. 5 p.

Anonymous 1999
Sri Lanka Fisheries Year Book 1999. Socio–Economic and Marketing Research Division, National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15, Sri Lanka. 62 p.

Barile L. E., A. D. Milla, A. Reilly & A. Villadsen 1985
Spoilage pattern of Mackeral (*Rastrelliger faughni* Matsui) I. delays in icing. Asian Food Journal 1: 2: 70-77

Beatty, S. A. & N. E. Gibbons 1937
The measurement of spoilage in fish. Journal of Biology Board, Canada, 3 (1): 77-91

Dorian, N. S., C. F. Graham, C. C. Judith & W. J. Ron. 1992
Spoilage changes in the deep water fish, Smooth Oreo Dory during storage in ice. International Journal of Food Science and Technology (27): 577-587

Ganegama Arachchi G.J., W.M.K. Perera, J.M.P.K. Jayasinghe, S. Jayasooriya, S. K. Hettiarachchi & J. M. Chandrika 1999
Quality and post harvest losses in off-shore tuna fishery in Southern and Western coasts of Sri Lanka. In: Proceedings of the annual session -55, Part I (abstract). 36 p. Sri Lanka Association for the Advancement of Science, Colombo, Sri Lanka.

Hemantha, D. & D. Amarasinghe 1994
Present status of Negombo fish landing center with special reference to pollution of the harbour environment. Report submitted to the Ministry of Fisheries and Aquatic Resources, National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15, Sri Lanka. 26 p.

Huss H. H. 1988
Fresh fish quality and quality changes. Training Manual. AO/DANIDA Training programme on Fish Technology and quality Control. FAO fisheries series. No 29. FAO, Rome. 132 p

Huss H. H. 1994
Assurance of sea food quality. FAO Technical Paper No 334. . FAO. Rome. 57 p

Jayaweera V., Sisira de Silva & J. C. Godakanda. 1988
Quality of Fish at Landing Sites along Southern Coast of Sri Lanka. NARA. Colombo. Sri Lanka. 37 p.

Lakshmanan P. T., C. Mathen, P.R.G. Varma, & T.S.G. Iyer. 1984
Assessment of Quality of Fish Landed at the Cochin Fisheries Harbour. Fishery Technology. 21(2): 98-108.

Niven C. F., M. B. Jeffry & D. A. Corlett. 1981
Differential plating medium for quantitative detection of histamine producing bacteria. Journal of Applied and Environmental Microbiology. 41(1): 321-332.

SLSI. 1983
Specification for potable water. Bacteriological requirements. Sri Lanka Standards 614: part 2: 1983. Colombo. Sri Lanka.

SLSI. 1992
Specification for ice for use in food processing and catering industries. Sri Lanka Standards 971:1992 (UDC 663.673: 641/642). Colombo. Sri Lanka.