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Handling practices and post-harvest losses of tuna catches from multi-day boats operating from fish landing site Negombo, Sri Lanka

G J GANEGAMA ARACHCHI[1*], J M P K JAYASINGHE[1], M J S WIJEYARATNE[2], W M K PERERA[3], S JAYASOORIYA[1], and K HETTIARACHCHI[1]

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

[2]Department of Zoology, University of Kelaniya, Kelaniya, Sri Lanka

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

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

Abstract

Tuna is one of the main fish resources from coastal and off-shore areas of Sri Lanka. It has been observed that there is a considerable post-harvest loss in this resource due to poor handling practices. The objective of this study was to study handling practices of tuna catches of multi-day boats (MDBs), infrastructure facilities available and to estimate the post-harvest losses. Tuna fish are mainly caught using gillnets. Nets are soaked for more than 6 hours before hauling. All boats studied were 12±2 m in length and with a single fish hold and a common shutter. The average depth of the fish hold was 2±0.5 m. In a fish hold, there were 5-9 compartments each with 2-4 shelves. Tuna, shark and other fish species were stored in the same fish hold. About 4 to 5 layers of fish were stacked in a shelf with ice. Crushed or flake ice was used in 1 fish : 2 ice ratio. Average temperature of fish in the fish hold was 2 °C, while average storing time of fish in boats was 16±7 days. Total time spent for a fishing trip was 21±9 days. Detergents were used to cleaning in 60% of boats. However the cleaning procedure did not include a sanitizing step. Fish were washed with water near the jetty of fish unloading area. Washing, gutting, selling of fish and dumping of fish wastes were done at a common site. Fish were not iced while displaying on floor for sale. Average temperature of fish in jetty was 17 °C. Based on sensory evaluation, average estimated post-harvest quality loss was 39% while estimated commercial post-harvest loss was 14%.

Prolonged soaking time of gillnets, inadequate icing of fish, higher temperatures in fish holds, over-stacking of fish in fish holds, long storing time of fish in boats, use of polluted ice and water and inadequate infrastructure facilities to

handle fish at the landing site contributed for the post-harvest quality deterioration and losses of tuna catch in the MDBs in Sri Lanka.

Introduction

Improper handling practices and inadequate infrastructure facilities have direct impact on quality of fish which leads to significant post-harvest losses. By minimizing the post-harvest losses, the quantity and quality of fish available to consumers can be increased. It will also contribute for the food security and sustainability of the fisheries industry.

Tuna fish is a high valued, popular food fish among Sri Lankan consumers. Production of tuna shows a gradual increase in the recent past. Total production of yellow fin tuna (*Thunnus albacares*), big eye tuna (*Thunnus obesus*) and skipjack tuna (*Katsuwonus pelamis*) from off-shore fisheries, was around 40,000 mt in 1998. Tuna species have become the second largest single commodity of export food fish, which accounts for 1390.98 mt, valued at Rs 178.86 M in 1998. These off-shore tuna resources are harvested by multi-day boats (MDBs) and in 1998 total production from these boats was around 70,000 mt (Anon. 1999).

Currently, yellow fin tuna and big eye tuna are the premier fish that are exported from Sri Lanka. Skipjack is also a potential food fish for the export market. In 1996 fishing fleet of Negombo consisted of about 200 MDBs (Anon. 1996). The total fish production from this area in 1998 was around 26,000 mt (Anon. 1999). The objective of the present study was to identify the factors responsible for post-harvest losses and to make recommendations for good and scientific handling practices of off-shore catches of Sri Lanka.

Materials & Method

Survey

The present study was conducted from April 1997 to October 1998 at the fish landing site at Negombo. Information were gathered on post-harvest handling practices, infrastructure of MDBs and landing site using a questionnaire and by interviews. The information on the size of boat and crew, type of fishing gear and size of the gear, size and partitioning of fish holds, pre-processing and storage methods of fish, duration of fishing trip, storage time of fish in boat, weight of tuna and total catch, weight of ice used in the fishing trip, cleaning methods and sanitary facilities to the crew were collected from the MDBs. Average ratio of fish to ice (wt:wt) was calculated dividing the weight of the total catch by the weight of ice used.

Temperature measurement

Core temperature of fish was measured by inserting a probe of a digital thermometer (Hanna, model EDEN C) into the pectoral fin area of the fish. Fish were sampled from the MDBs and the jetty of the landing site.

Categorization of the fish based on the sensory quality

Fish were assessed by four product-experienced panelists at the field using the method described by Hourigan and D'Mello (1977) with some modifications. A

freshness rating chart with five categories based on overall score for sensory quality of fish was used in this assessment. Five categories excellent, good, fair, poor and bad were denoted as QI, QII, QIII, QIV and QV respectively. The score ranges for excellent, good, fair, poor and bad categories were 25 - 21, 20 - 16, 15 - 11, 10 - 6 and 5 - 1 respectively. The sensory parameters considered were the appearance of the gill, the skin, the eye, texture, physical damage and smell of individual fish. The each parameter was assessed individually and individual scores were totaled to get the overall score per each fish. Different quality categories of fish were identified depending on the total score received for each fish.

Sensory quality based post harvest loss

Post-harvest losses in quality were estimated over the identified categories in the sensory assessment. Post-harvest quality loss (PHQL) was calculated using the formula given below. Indices of quality were given as 5, 4, 3, 2 and 1 to the QI, QII, QIII, QIV and QV quality categories respectively. Quality index for spoiled fish (i.e. QVI) was considered as zero.

$$PHQL = \frac{5 - \sum_{i=1}^{6} x_i q_i}{5}$$

Where:

PHQL = Post- harvest quality loss
x_i = Index of sensory quality category i
q_i = Relative abundance of fish in sensory quality category i in the catch

Commercial post-harvest loss

There were four commercial fish grades in the current market. Descending order of those commercial grades from good to bad were denoted as CI, CII, CIII, and CIV respectively. Commercial post-harvest losses were assessed using the relative abundances and current prices of all commercial grades.

$$CPHL = \frac{P_1 - \sum_{i=1}^{4} p_i c_i}{P_1}$$

Where:

CPHL = Commercial post-harvest loss
P_1 = Value of fish belongs to the highest commercial grade (grade I)

i	=	Commercial grade
4	=	Number of commercial grades
p_i	=	Value of fish belongs to commercial grade i
c_i	=	Relative abundance of fish belongs to commercial grade i in the catch

Results

Details of the infrastructure of MDBs fishing mainly for tuna and the fishing operations are summarized in Table 1. The length of the MDBs ranged from 10.0 m to 14.0 m with a mean value 12.0 m. Each MDB contained one fish hold. Fish hold was partitioned into 5 - 9 compartments using wooden panels. These wooden panels were dismantled upon unloading the fish. The fish hold had only one shutter. Each compartment contained 2 - 4 shelves. Vertical gap between the two shelves was >0.5 m in most of the boats. The depth of the fish hold ranged from 1.5 m to 2.5 m. All MDBs used gillnets to catch tuna. The number of net pieces in gillnets ranged from 37 to 97 while the size of the crew ranged from 4 to 6. The duration of a fishing trip ranged from 12 to 30 days with a mean value of 21 days. The fish were stored in the boat for around 16 days.

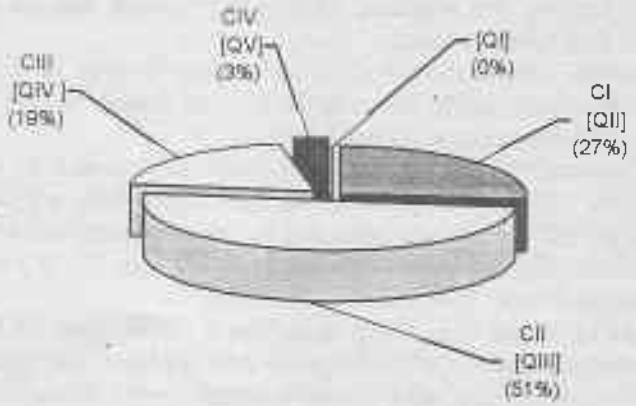
The gillnets were usually soaked for more than 6 hours before the haul. The fish caught were washed with seawater and stored in the fish hold belly up or belly down in the flaked or crushed ice. It was assumed that weight of the melted ice before being used to chill the fish was negligible. 90% of the boats used 1 fish : 2 ice ratio (wt:wt) while the rest used 1:1or 1 fish : <1 ice ratio (wt:wt).

When there were species other than tunas, they were stored in separate compartments in the same fish hold. The bilge water was usually removed form the fish hold. Unloading of fish at the landing site was done by hand to hand transfer. Upon unloading at the pier, fish were washed with harbour water. The fish with different shelf life periods got mixed at the landing site during unloading. After unloading of the catch, the boat including the fish hold, nets etc. was cleaned with harbour water. Only 60% of boats used detergents for cleaning. None of the boats used sanitizers.

Average temperatures of fish in the boat and at the landing site in Negombo were 2 °C and 17 °C respectively. At the landing site, fish were usually unloaded between 03:00 h and 10:30 h. Fish were displayed on the floor of the jetty and then carried in baskets for weighing. Hands also handled fish at the landing site. Washing, cutting and selling of fish were done at the same site. Only < 5% of this area had a shelter. The shelter of the jetty was also damaged and dirty. During the period of study there was no supply of potable water. The area was infested with flies and no barriers were available for stray animals and birds.

Table 1. Details on infrastructure facility and fishing operation of multi-day boats at Negombo landing site from April 1997 to October 1998.

Description	(Mean ±SD)
Size of boats (m)	12±2
Number of fish holds per boat	1±0
Number of compartments in fish hold	7±2
Depth of fish hold (m)	2±0.5
Number of horizontal partitions/shelves	3±1
Number of gillnet pieces	67±30
Number of crew members	5±1
Duration of fishing trip (days)	21±9
Storing time in fish hold (days)	16±7



C - Commercial grade (I - IV)
Q - Sensory evaluation based quality category (I - V)

Figure 1. Mean values of percentages of sensory evaluation based quality categories and commercial grades of the tuna unloaded from multi-day boats to the jetty at the Negombo landing site from April 1997 to October 1998.

The mean values of the percentage of tuna in different quality categories are shown in Figure 1. None of the fish were in the best sensory evaluation based quality category (QI). Relative abundance of fish in QII, QIII, QIV and QV quality categories were 0.2724 ± 0.2787, 0.5104 ± 0.258, 0.1948 ± 0.189 and 0.03 ± 0.079 respectively. Fish belonged to second quality category (QII) were found in the first commercial grade (CI). Only 27% of the catch was in the best commercial grade (CI). Majority of the fish (51%) were in the CII and group was equivalent to the third quality

category (QIII) Average post-harvest quality loss and average commercial post-harvest of tuna fish from multi-day boats were 39% and 14% respectively

Discussion

Gillnets are used to catch tuna in all MDBs sampled during the present study Considerable % of fish were found to be damaged due to this gear Fish get caught in the gill net and die several hours before the catch is hauled on board (Sorensen *et al* 1988) Hauling of fish usually can not be completed before dawn This delayed hauling leads to exposure of fish to sun for several hours at ambient temperatures before storing in the fish hold

Bulk stowage is practiced in the all MDBs Graham (1983) has suggested that 0 5 m as the maximum acceptable depth of shelves in bulk stowage but he has not specified the number of layers of fish or the size of the fish to be stacked in the specified depths Height between two shelves was well above 0 5 m in all MDBs studied It has been observed that tuna fish of 3 - 4 kg have been stacked in 4 - 5 layers and the two layers of fish at the bottom were mostly found to be crushed and deformed Therefore, it is suggested to have two layers of fish per shelf to prevent crushing of fish in bottom layers

Bonnell (1994) showed that the shallow stowage of fish minimized the weight lost by oozing out By reducing the physical damage to flesh, it can minimize the autolytic spoilage rate too (Bonnell 1994)

Therefore, number of horizontal partitioning should be increased or light weight shallow fiber glass boxes should be used to store fish in MDBs About 50% of boats stack the fish in belly side down and in others they are stacked belly up or in a random manner The recommended method is to stack the fish in a belly down position so that draining of belly cavity could be facilitated

The calculated ratio of fish to ice was 1 : 2, in many MDBs In the present study insulation capacities of the fish holds were not taken into consideration Since there is only one fish hold and a common shutter every fishing day that shutter had to be opened whenever fish were to be stored Therefore, some amount of ice get wasted due to ingress of heat into the fish hold by direct sunlight and convectional air currents However, if these factors had been taken in to account the net amount of ice available to chill the fish would be lower than that of in the calculated ratios Therefore, considering these factors the fish to ice ratio should be around 1 3 (wt:wt) in the fishing trips of longer duration

It has been reported that skipjack tuna and yellow fin tuna could be stored for a maximum of 15 and 24 days respectively at 0 °C temperature (Ilyas 1978. Jayaweera *et al* 1981) for acceptable quality However in these boats the average storage time was 16 days which is above the optimum period for skipjack tuna

Handling of fish at higher temperatures speeds up the onset of rigor mortis (Stroud 1969). Rapid rigor mortis causes unacceptable alterations in texture in subsequent stages of handling and increase the amount of extractives in fish muscle These high amounts of extractives make fish more susceptible for microbiological spoilage because extractives are the first medium on which microflora begin to grow in the flesh of fish (Johnston *et al* 1994) According to Stroud (1969) the undesirable effects of rigor mortis can be avoided by handling the fish under chilled condition at

every stage Therefore, soaking time of nets has to be reduced to few hours in the night. immediate icing of fish has to be carried out and shading should be provided during handling the fish on board in order to maintain the quality of fish at a better level

Only 60% of boats used detergents for cleaning Sanitizers were not used in any of the boats These incomplete and unsatisfactory cleaning procedures and use of polluted harbour water may result in building up heavy microbial loads in fish holds This will also adversely affect the quality of the fish Use of quaternary ammonium based disinfectants to clean holds, which is considered to be a good sanitizing practice (Throwe 1987) should also be carried out Separate areas for handling fish. preparation of foods for the crew and sanitary requirements of the crew should be provided

Auctioning of the catch is also done at the landing site premises during 0330 h to 1030 h parallel to unloading activity. Commercial grading of fish by subjective examinations prior to auction in the pier. make some degree of selection of good quality fish at subsequent stages in distribution chain However. chilling may mask the soft texture of deteriorated flesh of fish at the time of unloading.

Inadequate infrastructure facilities and poor handling cause the contamination and deterioration of quality of fish in the jetty Fish at the landing sites are not iced and core temperature is 17 °C Fish should be re-iced after unloading to maintain the continuity of the low temperature along the handling and distribution chain If trays or boxes were used to store fish in the fish hold, those iced fish in trays or boxes can be unloaded and the need for re-icing is avoided It was observed that considerable amounts of discarding ice from boats are collected to be used in fish transportation vehicles These discarding ice should not be re-used as it may lead to cross contamination Adequate shelter and space to carry out different activities during fish handling should be provided Barriers should be constructed to keep the stray animals away Potable water should be supplied to the landing site and easy accesses to ice should be provided Awareness programs on correct handling practices to the community in fish trade should also be carried out

No fish were found to be in the excellent sensory quality category (Q1) 27% of fish from MDBs were in the first commercially acceptable grade (CI) and 51% were in the marginally acceptable quality category (QIII) The results indicated that the quality of about 20% of the catch from MDBs were below the accepted quality level (QIV and QV) when the freshness was considered. Sensory evaluation based average post-harvest quality loss was estimated to be 39% in boats with an average of 21 days trip duration Unsatisfactory handling practices contribute significantly for this high post-harvest quality losses Commercial post-harvest loss which was 14% was less compared to the sensory evaluation based post-harvest quality losses Fish in rejectable sensory quality category were also auctioned at the landing site There was a big demand from dried fish producers for inferior quality fresh fish Difference in the prices among commercial grades were low due to this high demand. This has resulted in a reduction in the loss of value of the catch

Conclusions

Based on freshness rating assessment, post-harvest quality loss was around 40%. On average, only 1/3 of total fish produce from MDBs were in acceptable quality as fresh fish. The main factors contribute for high post-harvest quality losses in the multi-day offshore fishing boats are nets soaked for a long time, not maintaining chilling temperatures around 0 °C in the fish hold over-stacking of fish in shelves of the fish hold, extended storing time of fish in fish hold with long trip duration, use of contaminated ice and water to clean fish and boats and incomplete cleaning procedures in washing the boats. Cold chain of fish distribution is totally disturbed after unloading the jetty since fish is not re-iced. Handling of fish at the pier is very unhygienic. Estimates of commercial post-harvest losses were around 15% and there is no material loss for tuna catch from boats at the sales place. There is a demand for even inferior quality fresh fish for the dried fish industry.

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