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Quantitative and Qualitative Post-harvest Loss of Hilsa (*Tenualosa ilisha*)

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Abstract

This study was conducted in aims to assess the quantitative and qualitative post-harvest loss of hilsa. The data were collected using a semi-structured questionnaire from fishers (n=100) in Mahipur and Patharghata fish landing center. Hilsa fish samples were collected from four different stages (fishermen, aratdar, wholesaler and retailer) of supply chain. The study found that 50% fishers replied their fish has been spoiled 300-600 kg per year, 26% fishers said more than 600 kg and rest of 24% fishers replied it was spoiled less than 300 kg per year. There are so many reasons of post-harvest loss of fish. In this study 54% fish spoiled due to inadequate ice and insulated container, 26% fish spoiled due to high pressure during transportation, 14% fish spoiled because of inadequate storage facility. 24% spoiled by predator fish, 22% spoiled for damage during transportation, 18% for delay marketing, 10% fish spoiled for harmful fishing gear and 6% for long time fishing. The higher quality deterioration occurred when it passed through higher number of supply chain actors. This study revealed that both in Patharghata and Mahipur, better sensory quality with lower defect point (1.22 ± 0.52 and 1.41 ± 0.63) observed in fresh hilsa than other sources. Therefore, improved post-harvest handling practices should maintain to minimize the quantitative and qualitative losses of hilsa, thus to achieve food security for fishers and food safety for the consumers in home and abroad.

Keywords: Post- Harvest Loss, Supply Chain Analysis, Hilsa Fish

Introduction

Fish is one of the important sources of quality animal protein and availability and affordability for fish is better in comparison to other animal protein sources. Fish is the primary protein source in Bangladeshi diet contributing about 60% of total animal protein while per capita fish consumption in the country reaches 62.58 g, which is higher than their daily protein demand (60 g) as per the report of the (BBS, 2020) [3]. As an agro-based country, the contribution of fisheries to the national economy has always been essential and as the primary source of animal protein, employment opportunities, food security, foreign earnings and socioeconomic development (FRSS, 2020) [7]. Presently fish and fisheries sector contribute 3.52% to Bangladesh national GDP and around 26.37% to the agricultural GDP (DoF, 2020) [4]. Bangladesh has ranked 3rd in the world in inland fish production, 5th in aquaculture production and 11th in marine fish production in 2018 (FAO, 2020) [6]. Bangladesh is now self-sufficient in fish production and has started to get global recognition as one of the biggest fish producers among the countries (FRSS, 2020) [7]. Bangladesh is endowed with vast diversified fisheries resources which are broadly categorized into inland fisheries and marine fisheries. Inland fisheries are covering an area of 47.03 lakh ha, which has two sub-sectors, i.e., inland capture and inland culture (FRSS, 2020) [7].

Tenualosa ilisha (Hamilton, 1822) [9] of the subfamily Alosinae, family Clupeidae, order Clupeiformes, is one of the most important tropical fishes of the Indo-Pacific region and has occupied a top position among the edible fishes owing to its taste, flavor and culinary properties (Nowsad, *et al.* 2012) [14]. Hilsa serves as a health-food for the affluent world owing to the fish oils which are rich in polyunsaturated fatty acids (PUFAs), especially omega-3 PUFAs and at the same time, it is a health-food

for the people in other extreme of the nutritional scale owing to its proteins, oils, vitamins and minerals (Mohanty, *et al.* 2011) [11]. The Hilsa is a distinctive commercial fish in the Indo-Pacific area, notably in Bangladesh, India and Myanmar. It is a major migratory species in the Bay of Bengal, Persian Gulf, Red Sea, Arabian Sea, Vietnam Sea and China Sea (Hasan *et al*., 2016) [10]. The Padma-Brahmaputra and Meghna River basins, coastal areas, and the Bay of Bengal region account for up to 99 percent of the entire Hilsa catch (Rahman *et al*., 2012) [16]. About 3 million (2%) of the country's total population are directly or indirectly involved in the hilsa fishery for their livelihoods. Almost half a million people are directly involved in hilsa fishing which belonging to 184,000 families. 68% are full time, and 32% are part-time in different areas of Bangladesh (DoF, 2014; Halder, 2004) [5, 8]. From 1987 to 2018, with an increase of boats and gears, the numbers of hilsa fishers have increased in this sector. Most of these fishers are very poor, illiterate and do not possess any land for crop cultivation. Therefore, hilsa fishers earn their livelihood by catching and selling hilsa even if they have no other sources of income. Most of the hilsa fishers live below the poverty level; largely they are economically weak in terms of earning and availability of work (Pal *et al*., 2011; Siddique, 2009) [15, 17]. Most fishers (80%) do not own their boats. They borrow money from boat-owners and payback with 50% of the net return of catch sales. Usually, three types of fishers make up a crew, i.e. head mazhi, assistant head mazhi and bhagi/fishers. The number of bhagi depends on the size of the boat and the fishing net (Mome, 2007) [12]. The largest portion of hilsa is harvested from the coastal areas of Bangladesh, but 75% of total ilish is consumed outside of the coastal areas (Ahmed 2007) [1].

Fisheries sector in Bangladesh suffers from serious post-harvest loss every year due to ignorance and negligence of the people involved in different stages from the harvest to retail distribution. Previous research focused on estimation of local losses in wet fish distribution chain found about 20% of the marine fish landed in Cox's Bazar was deteriorated up to 80% of its original quality before it was loaded on the truck for distanced transport (Nowsad, 2004) [13]. About 28% fish lost 60 -70% of freshness quality before it reached the consumer in local retail wet fish trader's shop (Nowsad, 2010). Being a high lipid fish, the post-harvest loss of hilsa is also thought to be significant; and also, being a rapidly perishable tropical fish, proper handling is necessary to control and slow down spoilage of this valuable species. Hilsa are transported by plastic drum, steel made half - drum, country boat, sac made of hogla and polythene sheet, wooden, fiber glass or plastic craters, styrofoam box and ideal ice box. Post - harvest losses are found to be heavy during handling on-board vessel and in landing centers (Nowsad, 2010). About 20% of the marine fish was deteriorated up to 80% of its original quality before loaded and about 28% fish lost 60-70% of freshness quality before it reached the consumer (Nowsad, 2004) [13]. In addition, about 20- 30% in different fish and fishery products losses after harvesting, and 50% reduction of such loss can save Tk.8,000-10,000 core per annum (Nowsad, 2010).

A number of researches have been carried out on river fish and its supply system. Few studies have been taken in post-harvest losses of marine fish especially hilsa. No systematic study was conducted in post-harvest quantity and quality loss of Hilsa fish in southern part of Bangladesh. The study is aimed to determine the post-harvest quantity and quality loss and determine the reasons of post-harvest loss of hilsa fish.

Materials and Methods

Study area

For this study Mahipur and Patharghata fish landing center under Kalapara and Patharghata upazilla in Patuakhali and Barguna district were selected for assess qualitative and quantitative post-harvest losses of hilsa in southern Bangladesh.

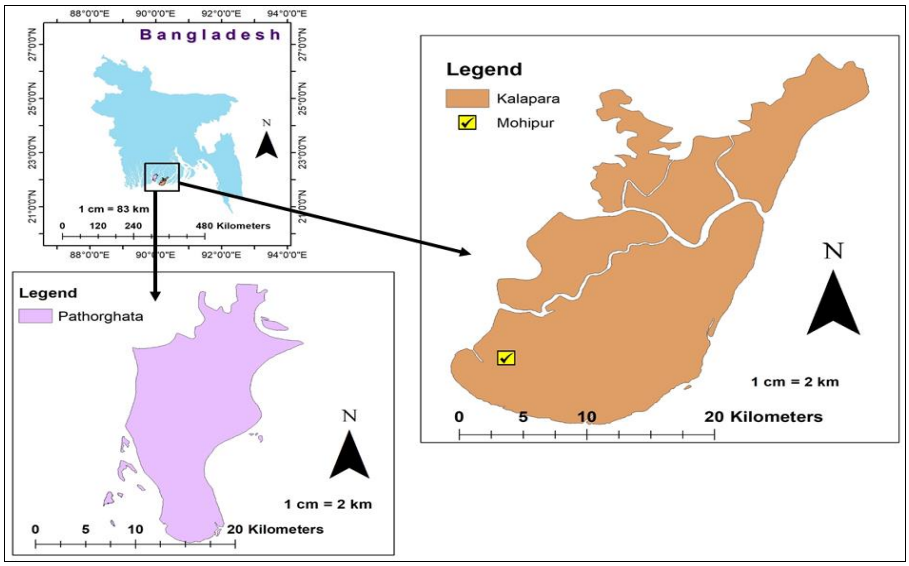

Fig 1: Location of the study area

Data collection

Primary data was collected from the study area from the July 2021 to June 2022. Semi-structured interview schedules were used to collect information from the two fish landing centers in the Patuakhali and Barguna district. Before collecting the primary data, a draft questionnaire was developed which was pre-tested in the fish landing centers and also with a few Upazilla Fisheries Officers (UFOs). In

the pre-testing, much attention was given to any new information in the draft questionnaire in order to reach the objectives of the study. According to the experience gained in pre-testing, the final questionnaire included the questions on fishing season, availability of fish species and price, features of fish landing centers and markets, sources and destinations of fish, problems related to fish markets and landing centers etc. Data was collected by face to face interview from fisherman, *aratdars*, wholesalers and retailers.

Data analysis

After completing the data collection, processed data were transferred to a preliminary data sheet of a computer and compare with computer spread sheets of MS Excel to ensure the accuracy of the data entry. After data entry, all the collected information was accumulated and analyzes by MS-Excel and then presented in textual, tabular and graphical forms using Microsoft office 2010.

Sample Collection

In this study, hilsa fish were selected for analysis of quantitative and qualitative post-harvest loss. Hilsa fish were collected from Mahipur and Patharghata fish landing center in order to find the quantitative and qualitative post-harvest loss. At first fishes were collected from fishermen, *aratdar*, wholesaler and retailer from Mahipur and Patharghata then collected sample brought to the "Sea Food Safety, Processing and Quality Control" laboratory under Department of Fisheries Technology, Patuakhali Science and Technology University (PSTU) with maintaining cold chain.

Fig 2: Hilsa samples from different steps of supply chain

Quality Analysis

Sensory Analysis

Sensory analysis of hilsa was evaluated by experienced students of fisheries 8th Semester (level-4, semester-2) and also MS Students, using 8 hedonics characteristics and scores for sensory evaluation. Odor of broken neck, color of gills, Slime of gills, body slime, eye, consistency of flesh, general appearance were observed and eleven (11) panelists who had been selected and trained were participated in the sensory evaluation. Defect point based on the characteristics was used to determine the quality of hilsa. Total defect point was divided by the number of characteristics in order to get average defect point. The fishes from different steps of supply chain was marked as F for fishermen, A for *aratdar* or landing station fish, W for wholesale market fish and R for retail market fish. The score of average defect points <2 was A grade considered as Excellent/ Highly Acceptable, 2 to 3 B grade was judged as Good/ Acceptable. > 3 to < 4 was C grade considered as Deteriorating, Not Acceptable and 4 to 5 grade D was considered as Spoiled/Rejected.

Table 1: Sensory Defects and defects points for assessment of quality loss of hilsa

Characteristics	Defects	DP	Observations			
			F	A	W	R
Odor of broken neck	a. Natural fishy odor					
	b. Faint odor					
	c. Sour odor					
Odor of gills	a. Natural odor					
	b. Faint sour odor					
	c. Moderate sour odor					
	d. Strong sour odor					
Colour of gills	a. Slight pinkish red					
	b. Pinkish red to brownish					
	c. Brown to grey					
	d. Bleached color					
Slime of gills	a. Thin colorless slime, filaments soft and separate					
	b. Sticky greenish slime, filaments separate					
	c. Yellowish slime, filaments attached					
Body slime	a. Clear, transparent, uniformly spread					
	b. Turbid, opaque					
	c. Thick, sticky, yellowish or greenish					
Eye	a. Bulging with protruding lens, transparent eye cap					
	b. Slight cloudy lens, sunken					
	c. Dull, sunken, cloudy, blood line/reddish cornea					
	d. Sunken eyes covered with yellow slime					
Consistency of flesh	a. Firm, elastic					
	b. Moderately soft and some loss of elasticity					
	c. Some softening of muscle					
	d. Limp or floppy					
General appearance	a. Full bloom, bright, shinning, iridescent					
	b. Slight dullness, loss of bloom					
	c. Definite dullness and loss of bloom					
	d. Reddish lateral line and caudal region, dull, no bloom					
	Average DP					

The formula is-

$$\text{Average Defect Point} = \frac{Total\ Defect\ Point}{Number\ of\ Characteristics}$$

Table 2: Quality grading of hilsha fish against defect points

Grade	Defect Point	Grade characteristics
A	<2	Excellent, Highly Acceptable
B	2-3	Good, Acceptable
C	>3-<4	Deteriorating, Not acceptable
D	4-5	Spoiled, Rejected

Fig 3: Sensory quality analysis of hisla from different steps of supply chain

Results and Discussion

Quantitative post-harvest loss of hilsa by Fishers

Table 3 shows, 50% fishers replied their fish has been spoiled 300-600 kg per year. 26% fishers said more than 600 kg and rest of 24% fishers replied it was spoiled less than 300 kg.

There are so many reasons of damage/spoil of fish. In this study 54% fish spoiled due to inadequate ice and insulated container, 26% fish spoiled due to high pressure during transportation, 14% fish spoiled because of inadequate storage facility. 24% spoiled by predator fish, 22% spoiled for damage during transportation, 18% for delay marketing, 10% fish spoiled for harmful fishing gear and 6% for long time fishing.

Most of the fishers (40%) sold damage/spoiled fish 200-250 Tk per kg. 36% fishers replied they sold their damage/spoiled fish 250-300 Tk per kg and rest of them (24%) replied they sold above 300 per kg.

Study represents that, most of the fishers (62%) loss price of damage/spoiled fish 200-400Tk per kg. Above 22% fishers loss price of spoiled fish more than 400Tk and 16% fishers loss price less than 200Tk.

Table 3: Quantitative post-harvest loss of hilsa by Fishers

S. No	Parameters	Category	Percentage
1	Damage/spoiled fish amount per year (kg)	<300	24
		300 - 600	50
		>600	26
2	Causes of damage/spoil of fish	Inadequate ice & insulated container	54
		High pressure during transport	26
		Inadequate of storage facility	14
		Long time fishing	6
		Delay during marketing	18
		Use of harmful fishing gear	10
		Damage by predatory fish	24
		Damage during transportation	22
3	Price of damage/spoiled fish per kg (TK)	200 – 250	40
		251 – 300	36
		Above 300	24
4	Price loss of damage/spoiled fish per kg (TK)	<200	16
		200 – 400	62
		>400	22

Quantitative post-harvest loss of hilsa by Traders

Table 4 shows, 48% traders spoiled their fish in 500-1000 kg per year. 22% traders spoiled their fish less than 500 kg, 18% traders spoiled their fish more than 1500 kg and 12% traders spoiled their fish less than 1000-1500 kg per year. Most of the traders (68%) sell damage/spoiled fish 200-300Tk per kg. 18% traders sell less than 200Tk per kg and 14% traders sell above 300 per kg. Study represents that, most of the traders (44%) price loss of damage/spoiled fish more than 400Tk per kg, 42% traders' price loss of spoiled fish 300-400Tk and 14% traders' price loss less than 300Tk. There are so many reasons of spoil/quantity loss of fish. In this study, 32% fish spoiled due to inadequate ice and insulated container, 48% fish spoiled due to high pressure in container, 80% fish spoiled because of inadequate storage facility. 14% spoiled by predatory fish, 54% spoiled for damage during transportation, 18% for higher marketing time and 26% fish spoiled for use of harmful fishing gear. Most of the traders (90%) sell lower prices.

Table 4: Quantitative post-harvest loss of hilsa by Traders

S. No	Parameters	Category	Frequency	Percentage
1	Amount of Spoiled/Damaged fish (kg) in a year	<500	11	22
		500-1000	24	48
		<1001-1500	6	12
		>1500	9	18
2	Price (BDT) of spoil/damage fish per kg	<200	9	18
		200-300	34	68
		Above 300	7	14
3	Price loss (BDT) per kg due to spoilage	<300	7	14
		300-400	21	42
		>400	22	44
4	Causes of fish spoil/quantity loss	Inadequate ice and insulated container	16	32
		High pressure in container	24	48
		Inadequate of storage facility	40	80
		Higher marketing time	23	46
		Use of harmful fishing gear	13	26
		Damage by predatory fish	7	14
		Damage during transportation	2	54
5	Destination of damage/spoiled fish	Through dustbin	0	0
		Gift to poor	0	0
		Sell lower price	45	90

Weight loss of hilsa (%) along the different supply chain

The investigation found that the hilsa fish experienced harsh handling and transportation, in case of Dhaka and others remote place more postharvest loss occurred during storage and transportation as compared to fish from landing centers in Mahipur and Patharghata. Table 5 showed weight loss of hilsa in four different supply chains. It is apparent that, weight loss of fish increase with transportation time but high percentage loss was observed when fish transported by using insufficient ice for transportation. The lowest weight loss were observed in landing center and then it gradually increase from landing center/*arot* to the retailer market. On average, reaching a retailer from a wholesaler reduce weight by 1 to 2 kg per mon (40kg).

Table 5: Weight loss of hilsa (%) along the different supply chain

Weight loss of fish (kg/mon)	Newly caught fresh hilsa (%)	Landing center/*Arot* (%)	Wholesale Market (%)	Retail Market (%)
No loss	100	100	21.22	09.00
0.2-0.5	00.00	00.00	06.01	7.49
0.5-1.0	00.00	00.00	15.19	18.53
1.0-2.0	00.00	00.00	30.30	37.70
2.0-5.0	00.00	00.00	27.28	27.28

Qualitative post-harvest loss

Sensory quality analysis of hilsa

Table 6, 7 and 8 presented the result of sensory quality analysis of hilsa. According to defect point method the qualities of the fishes were graded using the points from 1-5. Each of the samples was observed carefully and sensory were observed by a skilled panelist. The defect points (DP) were defined in terms of the total number of defects or demerit points. The points less than 2 was considered as highly acceptable, excellent, 2 to 3 were judged as good and also accepted, >3 to 5 were considered as in deteriorating condition and were not acceptable and rejected. In sensory analysis at Patharghata, the highest DP was found in hilsa fish from retailer (3.00±0.96) and lowest was found in fresh hilsa from fishermen (1.22±0.52). So hilsa fish from fishermen was excellent, highly acceptable and defect point was 1.22±0.52. However, at Mahipur, the highest DP was found in retail fish (2.38±0.84) and lowest was found in fresh hilsa (1.41±0.63). The fresh fish was excellent, highly acceptable and defect point was 1.41±0.63, landing center fish was excellent, highly acceptable and defect point was 1.60±0.78, wholesale fish was excellent, highly acceptable and defect point was 1.88±0.52 and retail fish was good, acceptable and defect point was 2.38±0.84.

Table 6: Sensory score of hilsa from different actors of supply chain in Patharghata

Sources of hilsa	General appearance	Odor of broken head	Odor of gills	Color of gills	Slime of gills	Body slime	Eye	Consistency of flesh	Overall average (n=64)	Grade Characteristics
Fishers	1.25±0.46	1.00±00	1.50±0.76	1.00±00	1.00±00	1.50±0.93	1.38±0.52	1.13±0.35	**1.22**±0.52	Excellent, Highly Acceptable
Aratdar	2.25±1.28	1.50±0.93	2.00±0.76	2.13±0.64	2.25±1.04	2.75±1.28	1.75±0.89	1.75±0.46	**2.05**±0.97	Good, Acceptable
Wholesaler	3.00±0.93	3.00±1.51	2.25±0.71	2.75±1.04	3.00±00	3.25±0.71	2.75±0.46	2.25±0.46	**2.78**±0.86	Good, Acceptable
Retailer	2.75±1.04	2.75±1.58	3.00±0.93	3.50±0.93	3.13±0.83	3.38±1.06	2.63±0.52	2.88±0.35	**3.00**±0.96	Good, Acceptable

Mean±SD (n=8)

Table 7: Sensory Characteristics of hilsa from different actors of supply chain in Patharghata

Sources of hilsa	General appearance	Odor of broken head	Odor of gills	Color of gills	Slime of gills	Body slime	Eye	Consistency of flesh	Grade Characteristics
Fishers	Full bloom, Bright, Shinning, Iridescent	Natural fishy odor	Natural odor	Slight pinkish red	Thin colorless slime, filaments soft and separate	Clear, transparent, uniformly spread	Bulging with protruding lens, transparent eye cap	Firm, elastic	Excellent, Highly Acceptable
Aratdar	Slight dullness, loss of bloom	Natural fishy odor	Faint sour odor	Pinkish red to brownish	Sticky greenish slime, filaments separate	Slight cloudy lens, sunken	Bulging with protruding lens, transparent eye cap	Firm, elastic	Good, Acceptable
Wholesaler	Definite dullness and loss of bloom	Faint odor	Faint sour odor	Pinkish red to brownish	Sticky greenish slime, filaments separate	Dull, sunken, cloudy, blood line/reddish cornea	Slight cloudy lens, sunken	Moderately soft and some loss of elasticity	Good, Acceptable
Retailer	Slight dullness, loss of bloom	Natural fishy odor	Moderate sour odor	Brown to gray	Sticky greenish slime, filaments separate	Dull, sunken, cloudy, blood line	Slight cloudy lens, sunken	Moderately soft and some loss of elasticity	Good, Acceptable

Table 8: Sensory Characteristics of hilsa from different actors of supply chain in Mahipur

Sources of hilsa	General appearance	Physical Damage	Odor of gills	Color of gills	Eye	Body slime	Consistency of flesh	Points	Grade Characteristics
Fishers	Full bloom, Bright, Shinning, Iridescent	No damage	Natural odor	Slight pinkish red	Transparent eye	Clear, transparent, uniformly spread	Firm, elastic	1.41±0.63	Excellent, Highly Acceptable
Aratdar	Full bloom, Bright, Shinning, Iridescent	No damage	Natural odor	Slight pinkish red	Transparent eye	Clear, transparent, uniformly spread	Firm, elastic	1.60±0.78	Excellent, Highly Acceptable
Wholesaler	Full bloom, Bright, Shinning, Iridescent	No damage	Natural odor	Slight pinkish red	Transparent eye	Clear, transparent, uniformly spread	Firm, elastic	1.88±0.52	Excellent, Highly Acceptable
Retailer	Slight dullness, loss of bloom	Slight defect in organs	Faint sour odor	Red to brownish	Slight cloudy lens	Clear, transparent, uniformly spread	Slight loss of elasticity	2.38±0.84	Good, Acceptable

Conclusions

The present study conducted to assess the quantitative and qualitative post-harvest loss and supply chain of hilsa at Mahipur and Patharghata fish landing center in Patuakhali and Barguna. Hilsa fish samples were collected from four different stages (fishers, aratdar, wholesaler and retailer) of supply chain. The higher quality deterioration occurred when it passed through higher number of supply chain actors. Therefore, improved post-harvest handling practices should maintain to minimize the quantitative and qualitative losses of hilsa thus to achieve food security for fishers and food safety for the consumers in home and abroad. In the present study, the quality aspects of hilsa from four different stage of supply chain were evaluated based on the sensory quality, proximate composition and microbial analysis to determine the qualitative post-harvest loss of hilsa at Mahipur and Patharghata fish landing center. Based on the sensory analysis it was found that hilsa samples from different sources of supply chain were good and acceptable and there is no significant quality loss in fish from fresh to retail stage. The moisture and ash content of hilsa samples were nearly same. The samples were found safe for the consumer in this study. However, there are some problems associating with hilsa fishery at Mahipur and Patharghata fish landing center. Inefficiency of transportation system and lack of ice were the major problems found in this study. Another major problem was load shedding. So, Government and private sector should be taken necessary steps to minimize these problems and build up awareness.

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