# Supply Chain and Logistics of Fish: A Case Study of Jamalpur District Markets in Bangladesh

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## ABSTRACT

Fishery sector plays a vital role in the socio-economic development of Bangladesh. In the fish economy of Bangladesh, one of the most flourishing traffic activities is fish marketing. This study was aimed to investigate the fish species availability, supply chain, quality loss, price behavior and constrains associated with fish marketing in order to provide better suggestion for efficient fish marketing in Jamalpur district of Bangladesh. Data were collected form Sadar upazila markets by using a structured interview schedule, focus group discussions (FGD) and key informant interviews (KII) with the stakeholders involved in supplying fish from farm to fork, such as- aratdars, retailers, and consumers during 2020-21. A total 78 fish species were found (72 Fresh water and 2 Marine water), among them 20 frequently, 17 less amount, 25 occasionally, and 16 species were rarely available in the market. It was estimated that 72% fish species were sourced from culture fishery whereas 28% were from capture fishery. About 91.5% fishes in Jamalpur markets were supplied locally, whereas rests were from other districts. The post-harvest quality losses of fish in the

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sampled markets were assessed which indicate that small indigenous species (SIS) spoiled quicker than medium to large sizes fishes due to different factors. The price behavior of the fish market influenced by the demand of the fish species, quality, size, catching sources (culture fishery or capture fishery) and the purchasing time (beginning, middle or last time of market). The study found positive correlation between the market price and fish quality. Several problems of fish market were identified resulting consumer dissatisfaction and financial losses for fish traders. Considering the importance of fish market to the economy, this study suggested to take necessary steps for establishing modern fish market to ensure the adequate quality maintenance of fish with efficient marketing.

## 1. INTRODUCTION

Bangladesh is surrounded by enormous fisheries resources with vast number of catching fish from culture and capture fisheries. It has placed as the third largest inland capture fish producing country after China and India [1]. Bangladesh, blessed with vast potential water resources, is one of the world's leading fish producing countries with a total production of 43.84 lakh MT in 2018-19, whereas inland open water (capture) contributes 28.19% (12.35 lakh MT) and inland closed water (culture) contributes 56.76% (24.89 lakh MT) to total production [2]. About 60% of Bangladeshi people eat fish as their main source of animal protein [3]. This country achieved self-sufficiency in fish production with a per capita fish consumption of 62.58 g/day against set target of 60 g/day [4]. The fisheries sector of Bangladesh contributes 3.61% to national GDP (Gross Domestic Product) and around one-fourth (25.30%) to the agricultural GDP [5]. It is the second largest source of export earnings of the country [6,7]. More than 12% of the population in Bangladesh is directly or indirectly engaged in various activities under the fisheries sector for their livelihood activities [2]. More than17 million people, including 1.4 million women depend on fisheries sectors for their income sources who involves mainly in harvesting, handling, trading and processing [8]. However, it should be noted that more than 80% of worker in the fish processing industries are women [9].

Fish production and marketing is the integral part for the socio-economic development of the agro-based country like Bangladesh. There is a strong value chain from the fish farm to fork. Because of perishability, fish supply chain in Bangladesh is relatively free from traders' market power whereas, country's cereal sector is suffering from high degree of market power [10]. Fish are harvested from culture and capture fisheries and display for trading in the market via different marketing channels. The fish species abundance to the market depends on the fish production by aquaculture and from the inland water resources of the respective location. Fish is perishable food and its quality deteriorates rapidly due to different factors. Most of our consumers like premium quality fresh fish but our existing marketing system and working personnel cannot meet this requirement. As a result, in the most cases our consumers were not satisfy and deprived from good quality fish although they were spending enough money. The fish quality depends on various marketing factors. Successful, sustainable fish marketing depends on effective distribution system with proper cool chain maintenance. The ultimate satisfaction of the consumers depends on effective fish marketing system where he will be able to buy good quality fish at reasonable prices. The deterioration of fish quality starts from harvesting, with increasing the intensity during transportation and become so interrupted after a long-time exposure in the fish market, which ultimately cause the consumers' dissatisfaction. In the fish market, traders did not give ice to fish for adequate quality maintenance that result the increase of fish temperature, which accelerate fish spoilage. They are not applying the best practices in storing fish, because of lack of facilities and unwilling to spend more money on storage. Nowsad [11] showed that the fish quality deteriorates due to the preservation and transportation methods, availability of ice during transportation and selling period. About 35% of the quality loss may occur due to longer exposure of fish at high temperature, whereas about 25% can be for rough handling and excessive pressure [12]. The SIS (Small Indigenous Species) was rapidly spoiled than medium to big sizes fishes [13]. Hossain et al. [14] added that the quality of the SIS fishes is lost due to ignorance and/or negligence of

people during harvesting and post-harvest handling. The price of the fish depends on supply and demand as well as the quality of fish [15]. The fish species from same water body with different quality have considerable price gap in the market. The problems regarding fish quality resulting serious economic losses for the fish farmers, traders, as well as for consumers. The carelessness systems of existing fish market have adverse impact on farmers, fishermen and poor traders [16].

Jamalpur is an important district for fisheries resources although it is far from achieving self-sufficiency in fisheries. There are enormous numbers of natural water body like as two big rivers name Jamuna and Brahmaputra, many small and large beels crossed around the Jamalpur district where vast amount of fresh water fish species which are available in the fish markets are sourced. Alongside there are developed strong aquaculture (closed water body) production which supply plenty of fish in the district markets. During 2018-19 the total amount of fish production in Jamalpur district was 34342 MT, where 2950 MT was from river, 3190 MT from beels, 9112 MT from floodplain, 16415 MT from ponds and 2139 MT from seasonal cultured water body [2]. Most of those fishes are supplied through different marketing channel with multiple intermediaries from fisherman/farmer to the consumer level. It is very common scenario in Bangladesh. Deb and Dey [17] found that 95% of the supplied fish in the Sylhet region comes to the market through different intermediaries. The related studies in the literature sated the fish marketing system in different districts of Bangladesh [12,18,19,20] where Jamalpur district is absent. Moreover, the documented studies only focused on the marketing system and contribution of different channels to fish supply in the market. Some studies also observed the status of fish quality in the market. Hossain and Barman [21] assessed the quality loss of SIS in the Sylhet region of Bangladesh at the post-harvest operating period and found that after the morning period, the quality of fish in the market deteriorates gradually. On the other hand, Hossain et al. [22] observed that quality loss of carp fish deteriorates in the retail level rather than the farm and wholesale levels. Any study by our knowledge assessed the marketing system and quality loss of fish in the Jamalpur markets. Therefore, this study aimed to judge the quality change (logistics) of fish during marketing in the Jamalpur Sadar upazila markets along with the

marketing systems and give suggestion for adequate quality maintenance in the market. This is the first study of its kind as a case of Jamalpur district. The findings of the study would generate effective information to understand the supply chain and logistics of fish in Bangladesh.

## 2. MATERIALS AND METHODS

### 2.1 Study Location and Data

The present study was conducted in the Sadar upazila of Jamalpur district (see Fig. 1). Different fish markets of the upazilas were surveyed to collect the primary information on fish species availability, supply chain, quality, price behavior at different time spend after marketing. Besides, constrains of the market as well as suggestion to overcome the problem have been gathered from the survey. The study used both the primary and secondary data. The data were collected over the period of 1 year from April, 2020 to March 2021. A combination of different survey techniques was used to collect data. A structured and pretested interview schedule has been used to conduct the survey. Moreover, Focus Group Discussions (FGD) and Key Informant Interviews (KII) techniques were used for collecting primary data. The face-to-face interviews were conducted with 12 aratdars, 54 retailers and 93 consumers using the structured questionnaire. They were interviewed by formal conversations and data were recorded in the record book. Information about fish species diversity, value chain, pricing policy, socio-economic conditions of traders, satisfaction of consumers regarding fish quality, constrains of fish marketing and suggestion to improve the existing condition were the topics of the interviews. FGDs were conducted with fish traders and consumers to get a clear overview on fish availability, value chain, distributions and marketing systems, consumers satisfaction, constrains of marketing etc. A total of 8 FGD sessions were conducted with the group of 5-7 persons about 1.30 hours duration. The key informants are special knowledgeable person on a particular topic and are expected to be capable to answer the question about the knowledge and attitude of others. Cross-check interviews were conducted with researchers, leader of traders, policymakers, and relevant non-governmental organization (NGO) workers. Further investigation has been executed if contradictory information generated. Secondary data were collected from Department of Fisheries (DOF),

Department of Agriculture Marketing (DAM) and various published literatures.

## 2.2 Fish Quality Analysis

The quality of the fishes was judged during direct observation at the data collection time in the market. The organoleptic quality tests were assessed by well-known sensory analysis method proposed by Howgate et al. [23]. For easy judgment, the fishes in the market were divided broadly into two groups- medium to big size fishes and SIS. The different organoleptic characters (see Table 1) were assessed in defect points (DP) and the averages of the defect points were compared with the grades (see Table 2), which indicate the fish quality.

## 2.3 Data Processing and Analysis

The data were coded and recorded into a database system by using Microsoft Excel software. Preparatory data sheets were compared with original data sheets to ensure the accuracy and quality of the data. The defect points of the fish were estimated using the simple arithmetic by following the guidelines of Tables 1 and 2. The contribution of different fish species and their sources were graphically represented using the Microsoft Excel software.

## 3. RESULTS AND DISCUSSION

### 3.1 Availability of Fish Species in the Sampled Markets

Jamalpur district, north-central part of Bangladesh lies on the west bank of the old Brahmaputra River. The total area of this district is 2115.16 km$^2$ and the number of total populations is 2,29,2674 [24]. The total fish production was 34342 MT in 2018-19 in Jamalpur district [2]. The fish availability depends on the demand and supply of fish in the market that reflects by the fish production in the culture and capture fisheries, and the communication and transport facilities with other districts. The fish composition also varied with the season and time. In our study period fish species in the market varied during different seasons. A total of 78 fish species were observed where 72 were fresh water species and 2 were marine water species in the sampled markets (see appendix Table A1). Among them 20 fish species frequently, 17 less amount, 25 occasionally, and 16 species were rarely available in the market during the study period. In the market, the inland closed water (culture) species was dominant 72% whereas the contribution of open water (capture) species was only 28% (Fig. 2). For easy discussion, this paper used the local name of the available fish species in the sampled markets. However, the scientific and English names of the fish species are presented in the appendix Table 1. Among the culture species Rui, Catla, Mrigal, Grass carp, Bata, Silver Carp, Pangas were dominant and on the other hand mainly SIS of capture species like as Puti, Taki, Pabda, Mola, Chapila, Gutum were the foremost. Hilsha and Bagda chingri were leading position from marine and brakish water species. These findings are much convenient with Chandra et al. [25] where they observed 99 freshwater fish species and 14 marine fish species in the 16 fish markets and five important fish landing centers of Mymensingh districts.
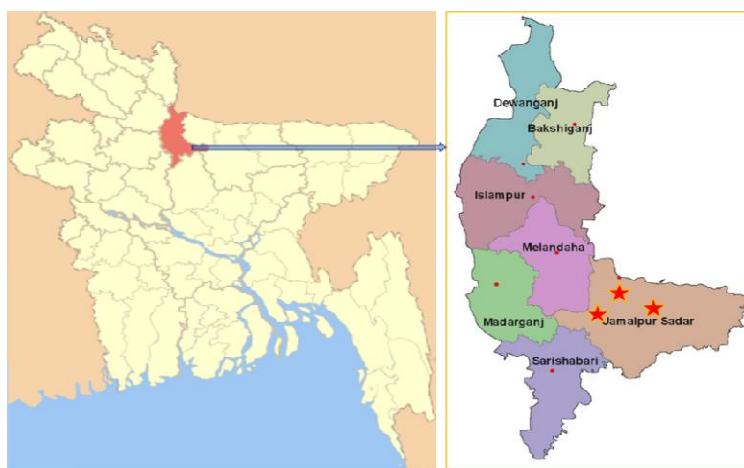


**Fig. 1. Study location**
*Note: The 'star' marks indicate the Sadar upazila markets area in Jamalpur district of Bangladesh.*

**Table 1. Attributes and defect points for quality assessment of wet fish**

| Characteristics | Defect | Defect Point | Grade |
|---|---|---|---|
| Odor at neck when broken | a). Natural odor | 1 | Acceptable |
| | b). Faint or sour odor | 5 | Rejected |
| Odor of gills | a). Natural odor | 1 | Excellent |
| | b). Faint or sour odor | 2 | Acceptable |
| | c). Slight moderate sour odor | 3 | Acceptable |
| | d). Moderate to strong sour odor | 5 | Rejected |
| Color of gills | a). Slight pinkish red | 1 | Excellent |
| | b). Pinkish red or brownish | 2 | Acceptable |
| | c). Brown or gray color | 3 | Acceptable |
| | d). Bleached, thick yellow slime | 5 | Rejected |
| General appearance | a). Full bloom; bright, shining; iridescent | 1 | Excellent |
| | b). Slight dullness and loss of bloom | 2 | Acceptable |
| | c). Definite dullness and loss of bloom | 3 | Acceptable |
| | d). Reddish lateral line; dull, no bloom | 5 | Rejected |
| Slime | a). Usually clear, transparent and uniformly spread | 1 | Excellent |
| | b). Becoming turbid opaque and milky | 2 | Acceptable |
| | c). Thick, sticky, yellowish or green in color | 5 | Rejected |
| Eye | a). Bulging with protruding lens; transparent eye cap | 1 | Excellent |
| | b). Slight cloudy of lens and sunken | 2 | Acceptable |
| | c). Dull, sunken, cloudy | 3 | Acceptable |
| | d). Sunken eye covered with yellow slime | 5 | Rejected |
| Consistency of flesh | a). Firm and elastic | 1 | Excellent |
| | b). Moderately soft and some loss of elasticity | 2 | Acceptable |
| | c). Some softening | 3 | Acceptable |
| | d). Limp and floppy | 5 | Rejected |

*Note: Fish quality assessment follows the technique developed by Howgate et al. [23].*

**Table 2. Grading of fish on the basis of the defect points**

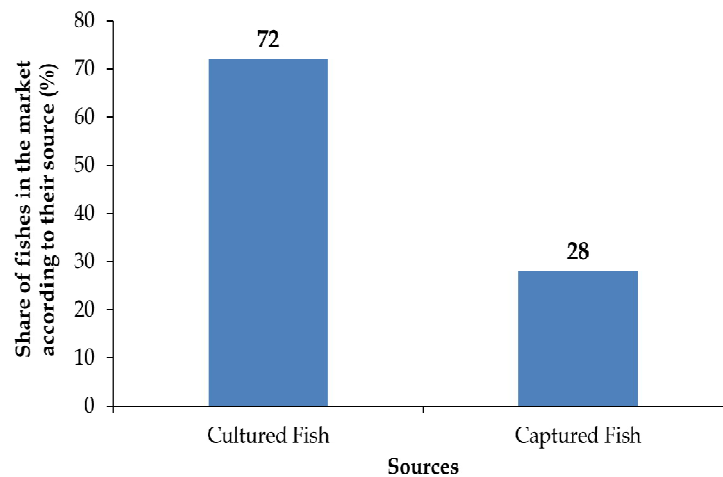| Grade | Defect Points | Comments |
|---|---|---|
| A | <2 | Excellent / Acceptable |
| B | 2 to <5 | Good / Acceptable |
| C | 5 | Bad / Rejected |



**Fig. 2. Share of different sources on the available fishes in the sampled markets. Prepared by the authors' based on the information from survey**

There is a vast resource of culture and capture fishery in the Jamalpur district. The Old Brahmaputra river, Jamuna river, beels are the main sources of inland capture fishery alongside there are developed many aquaculture farms which makes this district a strong base of culture fishery. Both of the culture and capture fisheries make sufficient fish production in this area. Among the available fishes in the Jamalpur sadar markets, the contribution of own district (Jamalpur) is 91.5%, whereas the rest of the fishes were supplied from other districts (Fig. 3). According to the survey findings, the contribution of Natrokona district to the Jamalpur markets (Fig. 4) were the highest (3.5%) among other districts, followed by Chattogram (2%), Rajshahi (1.5%), and Barishal (1.5%). Different types of inland culture species of *haor* areas like as Boal, Air, Baghair, Kakila, came from nearby Natrokuna district which is surrounded by haors. The chalni fish Rui, Catla came from Rajshahi. Different types of brakish and marine water species were brought from Chattogram and Barishal. The total annual fish production of Jamalpur district was 34342 MT where 2950 MT from river, 3190 MT from beels, 9112 MT from floodplain, 16415 MT from ponds, and 2139 MT from seasonal cultured water body in the year 2018-19 [2]. Al-Hasan et al. [26] observed that, most of the fish (85%) were brought locally from different rivers and ponds of the Barisal region, and the rest (15%) from other district markets of Barishal district which is more or less similar to our study. Aktar et al. [27] recorded 80% fish were from different areas of the Noakhali district and the remaining part 20% from other districts.
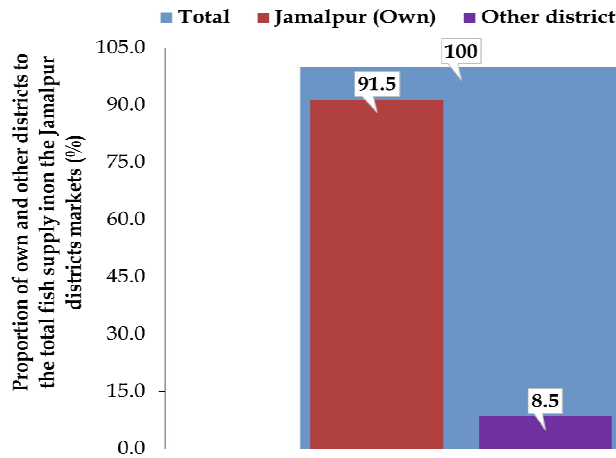


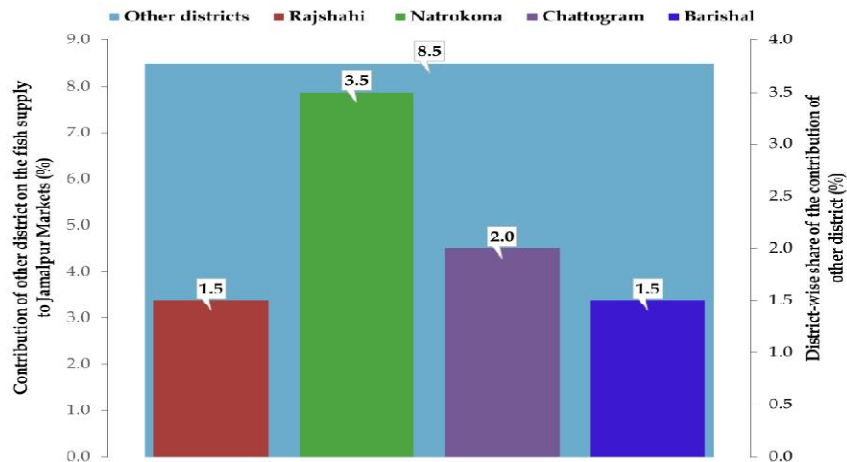**Fig. 3. Fish supply scenario in the Jamalpur markets. Prepared by the authors' based on the information from survey**



**Fig. 4. Share of the other districts on the fish supply to the Jamalpur markets. Prepared by the authors' based on the information from survey**

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## 3.2 Fish Distribution Channels

The distribution channel plays a major role in controlling the quality and price of the commodity. Depending on the marketing services and the physical environment, the distribution channel could be short or long. A stable network is set up between demand and supply through the supply channel. Normally, the producers/fishermen sold their catch via different intermediaries. Fish distribution channel is the bridge from producer to consumer through some intermediaries or middlemen. Fishermen are the prime producer in the fish marketing system. With some exceptions they do not have direct communication with the consumers. The fish supply chain in the sampled markets of the Jamalpur district is sketched in Fig. 5. The Paikers (agent) carried out fishermen's catch to the fish markets by their vehicles and sell them to the retailers with the assistance of aratdars. Some of the fishermen delivered their catches to retailers with the help of aratdars. There were seven marketing channels in the sampled markets of Jamalpur district. In the most cases (55%) fishermen/producers sold fish to the paikar and they sold to the retailer with the help of aratdar. The findings of the study also revealed that the farmers partially sell their fish to the aratdars (about 25%) and the aratdars sell it to the retailers and finally consumers. Fishermen also sold (10%) directly to the wholesaler in the study area. In a very rare case, fisherman sold 3% of the fish directly to the consumers. In case of Hilsha, Shrimp and other marine and brackish water fish species from distance place were followed the supply chain 6 (3%) and 7 (2%).The channel-wise fish supply in the Jamalpur district has been summarized in Box 1. The appropriate marketing channel depended upon the volume and quality of fish catch, distance of the market, and the demand of the consumers [28]. Alam et al. [12] also found a similar marketing channel in Swarighat of Dhaka district. Five types of marketing channels were identified in the fish market of Noakhali district, which is closely related to our study [27]. Uddin et al. [29] observed 3 marketing channels in the fish market of Bagura districts. Ali et al. [30] found 5 fish marketing channels in the fish markets of Dumki upazila, Patuakhali. The contribution of different channels to fish supply in the respective markets is very much close to the findings of this study.
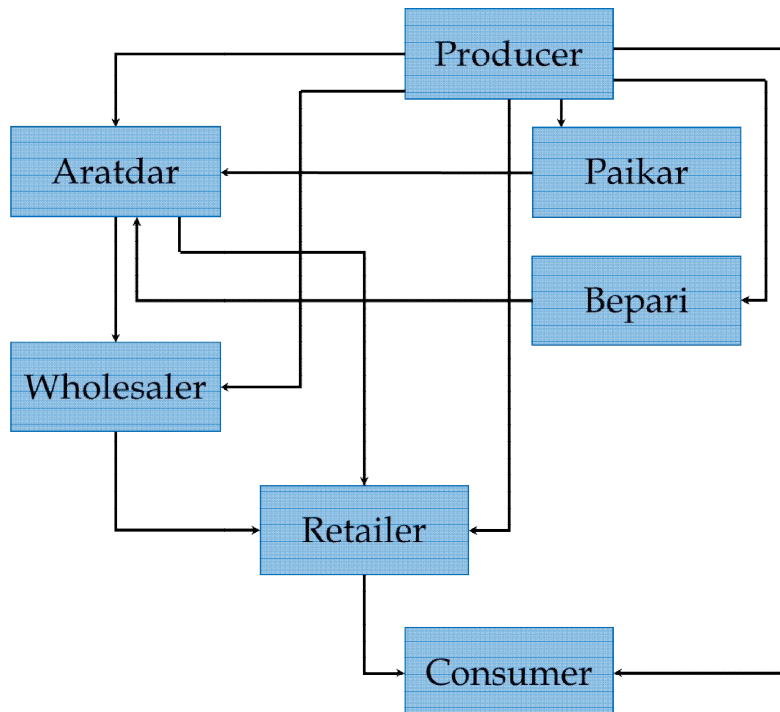


**Fig. 5. Fish supply chain in the Jamalpur district of Bangladesh. Prepared by the authors' based on the information from survey**

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**Box 1: Different fish supply channels in the Jamalpur district of Bangladesh**

The study has identified seven different supply channels of fish in the study area. These are as follows:

**Channel 1**: $Fishermen/Producer \rightarrow Consumer$ (3%)

**Channel 2**: $Fishermen/Producer \rightarrow Retailer \rightarrow Consumer$ (7%)

**Channel 3**: $Fishermen/Producer \rightarrow Wholesaler \rightarrow Retailer \rightarrow Consumer$ (10%)

**Channel 4**: $Fishermen/Producer \rightarrow Aratdar \rightarrow Retailer \rightarrow Consumer$ (25%)

**Channel 5**: $Fishermen/Producer \rightarrow Paikar\ (Commission\ agent) \rightarrow Aratdar \rightarrow Retailer$
$\rightarrow Consumer$ (55%)

**Channel 6**: $Fishermen/Producer \rightarrow Aratdar\ (Commission\ agent) \rightarrow Wholesaler \rightarrow Retailer$
$\rightarrow Consumer$ (3%)

**Channel 7**: $Fishermen/Producer \rightarrow Bepari \rightarrow Aratdar\ (Commission\ agent) \rightarrow Wholesaler$
$\rightarrow Retailer \rightarrow Consumer$ (2%)

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## 3.3 Post- Harvest Quality Losses

Generally, the retail market in the survey areas starts at 9 AM and continued till 6 PM as like as other parts of Bangladesh. Moreover, the wholesale market starts at 7.30 AM and to be continued till 11.30 AM. In the study markets, most of the fishes were found excellent quality (DP>2) at the beginning of the retail market where the quality deterioration started very slowly by time being. However, the quality becomes the worst at the lapsing time of the market operating period. Middle to big sizes fishes were found acceptable (DP<5) at the end of the market time (6 PM) but the quality loss is very much near to rejection due to inadequate ice and fish ratio, unhygienic condition of the market and other causes of quality losses (Fig. 6). On the other hand, SIS were found acceptable (DP<5) up to the 4 PM and finally rejected (DP>5) at 5 PM due to not using ice, harvesting gear and time spend (Fig. 7). Small fishes were found more susceptible to spoilage than middle to big size fishes. Along with organoleptic test in the fish market during observation, the data were also collected from aratdars, retailers, consumers, and sometimes from fishermen to identify the causes of fish spoilage in the value chain where we found that, the deteriorations were more or less common pattern. However, harvesting time, fishing gears, temperature, ice and fish ratio, hygienic condition of the market, distance from harvesting areas and communication type were liable for the variation of quality losses of two groups of fishes (medium to large size and SIS). Generally, most of the fish species of medium to large groups were from culture fishery, which fishing with Ber jal (surrounding net) prior to starting of market whereas SIS were from capture fishery caught by different types of fishing gears like as Jhakhi jal (cast net), Chabi jal (lantern net), Fash jal (drift net), Dharma jal (hand lift net), Fash jal (drift gill nets) and other types of gears where fish become exhausted and also passed a long time after harvesting that triggers susceptibility to spoilage. Moreover, the fish carrying system from the harvesting place to market were found different as well as the transportation varies between the two groups.

These findings are very much relevant with the similar studies in Bangladesh perspective. Hossain & Barman [21] found that the SIS quality of fishes was deteriorated due to delay in storage time in Sylhet region. Nowsad [11] observed that SIS of fresh water was more susceptible to spoilage due to their comparative small size and vulnerability of constituent proteins and lipids. It is also stated that the preservation method, transportation systems, availability of ice during transportation and selling period affects the SIS quality. The SIS quality was lost during harvesting and post-harvest handling owing to ignorance and/or negligence of the people during harvest, distribution and processing [14].

## 3.4 Price Behavior of the Sampled Fish Markets

Fish price varied with season, size, availability and quality in the study markets. In most cases prices of fishes mostly depended on the supply and demand as well as fish quality. The fish prices were recorded highest during the starting time of the market (9 Am to 12 PM), moderate at middle time (12 PM to 3 PM) and lowest at (3 PM to 6 PM) due to the quality loss of fishes with time lapsing, which lessen the demand and satisfaction to the consumers and ultimately price variation occurred. Moreover, fish prices also varied according to the sources, whether it was from culture fishery or capture fishery (see appendix Tables 2 and 3). The price of catfishes

from both culture and capture were varied with live or death condition. There were different groups of fishes like, Indian major carps, cat fish, berbs, perch, miscellaneous. Indian major carps and cat fishes were highest demand to the consumers. Consumers preferred capture fish but the price was high compare to the similar species of culture fish. However, the quality of the captured species from river and beels were deteriorated rapidly than culture species. Rui showed the highest price from Indian major carps in both groups (culture and capture fishery). The lowest prices were found for Pangas fish (catfish) and Silver carp (IMCs) from the culture fishery. Although Shing, Magur, Koi were popular species in the market, consumers showed less interest to the culture species with low prices (see appendix Table A2). In the capture fishery, most demandable with high prices fishes were Batshi, Kajoli, Boal, Air, Mola, Dhela, Shaplapata (see appendix Table A3) from local species. Marine water species Hilsha showed highest demand with high prices to the market during different occasion whereas brakish water species shrimp showed the similar pattern. In the different occasion like Ramadan, Eid, the fish prices were increased in the market. On the other hand, Hilsha price increased rapidly during the Pahela Baishakh and also the starting time of harvesting season. Moreover, it is also observed

that the quality deterioration has strong positive correlation with the price irrespective of the size and sources (see Figs. 8 and 9). As the defect points increase, the market price of fish decreases with the time lapse in the market.

Rahman et al. [31] stated that the fish price varied considerably depending upon the species, marketing channel, freshness, weight and source of fish, seasonal availability, consumer preference, and demand. These findings are much relevant with the findings of this study. Debnath et al. [32] stated that the Indian major carps were more highly priced than the exotic species. Rohu was found to be the most expensive in southwest Bangladesh [33]. Rahman [34] reported that major carps such as, rohu, catla, and mrigal fetched higher price than exotic carps in Gazipur district. Shrivastava and Ranadhir [35] reported that rohu, catla and mrigal are the highly priced fish in India. Afroz [36] stated that, the demand of fish became higher during Ramadan that leads the price of fish to be higher than other months. Shang [37] reported that the price usually fluctuating seasonally due to the variation in supply and demand of fish. Quddus [38] observed that, fish price is influenced by seasonably, abundance, market structure and origin of fish.
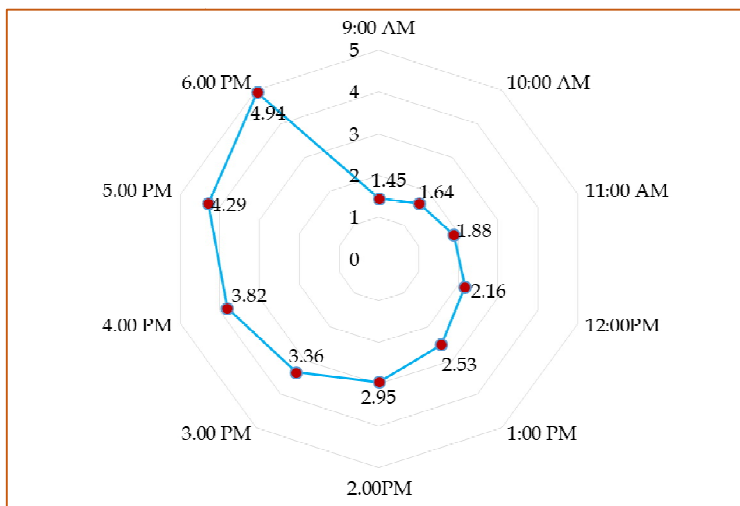


**Fig. 6. Average defect points of medium to big size fishes over the time spend in the market**
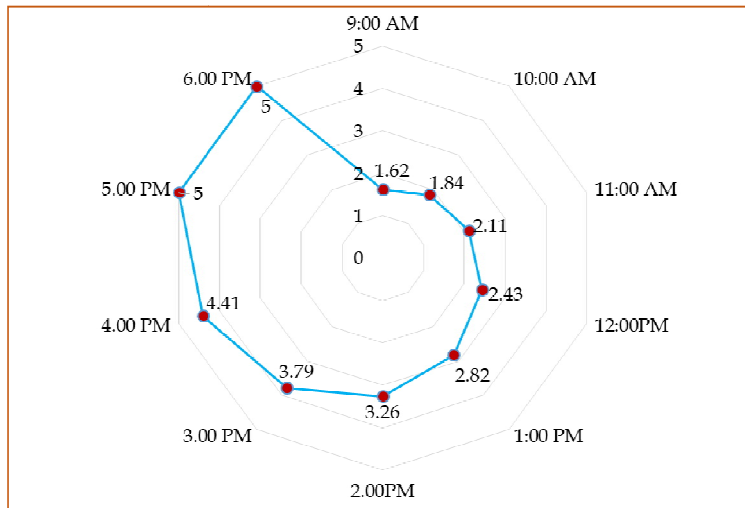
**Fig. 7. Average defect points of small fishes (SIS) over the time spend in the market**
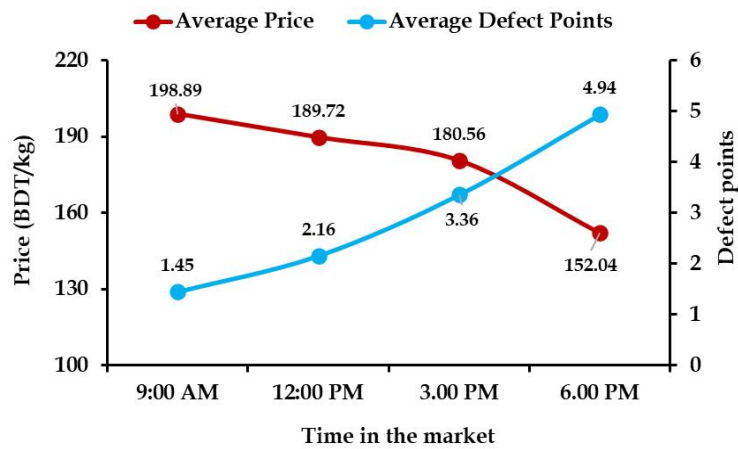


**Fig. 8. Relationship between the defect points and market price of medium and large size fish by the time spend in the market. Analyzed and prepared by the authors based on the information from market survey**
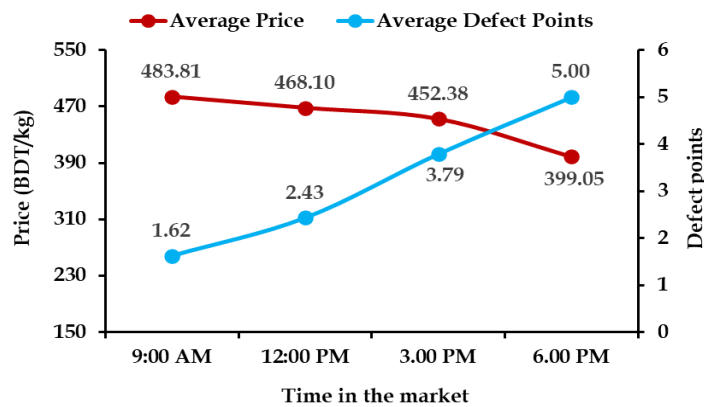


**Fig. 9. Relationship between the defect points and market price of SIS by the time spend in the market. Analyzed and prepared by the authors based on the information from market survey**

## 3.5 Constraints of Fish Marketing

A number of constraints for fish marketing were reported by fishermen, aratdars, retailers, and consumers during the market survey. Maximum numbers of respondents (21%) opined that poor infrastructure is the main problem and minimum (2%) reported that the absence of toilet facilities in the market. About 18% respondents mentioned unhygienic sanitary conditions, 14% reported lack of capital, 13% mentioned low fish price, 9% claimed poor drainage facilities, 7% said inadequate water supply and 3% reported higher transport cost and rough fish handling problem in the sampled markets (Table 3). Almost similar problems of the fish markets have been identified by many literatures in Bangladesh perspective. Ali et al. [30] found the lack of electricity, poor transport system, poor drainage system, poor platform facilities, inadequate ice facilities, inadequate water supply system, and poor sanitation system at local markets. Similar types of constraints for fish marketing were reported by the retailers where the highest proportion of respondents (26.67%) identified the lack of infrastructure and 25% of respondents identified the lack of storage facilities as the main constraint of fish marketing as well as 21.67% respondent identified exploitation by middlemen, 11.67% identified poor supply of ice and 15% identified the lack of money at the three markets of Barishal [26]. Different types of constraints for fish marketing were reported by retailers during survey whereas 60% identified the lack of capital, and 17% of respondents identified higher transport cost, 9% respondents identified getting lower price as a result of exploitation by middlemen, 6% mentioned poor supply of ice and 8% respondents identified unhygienic market

place in the district of Noakhali [39]. The main constraints to fish marketing were related to market infrastructure, which was related to other factors. The lack of icing facilities, hygienic condition and the ignorance of the fish handling that causes serious problems of fish quality which reduced the fish price as well as unsatisfied the consumers. However, inadequate transportation and distribution facilities along the value chain were also liable for increasing the fish price in the market. Alam et al. [12] mentioned that marketing costs are high if the marketing functions are not performed efficiently due to difficulties such as poor roads, inadequate storage leading to losses, poor handling, etc. Uddin et al. [29] mentioned that higher production costs, higher harvesting and transport costs, poor road communication facilities, poor supply of ice, higher demand of labors, exploitation by middlemen, lack of capital, inadequate drainage system, poor water supply, poor sanitary facilities, unhygienic conditions were the constrains of fish markets in Bogura district. Kabir et al. [40] and Amin et al. [41] mentioned that most of the fishermen were facing different types of problems during marketing their commodities. The consumers paid highly their goods due to the participation of too many intermediaries in the value chain, but the fishermen or producers did not get the ideal price for their commodity as the maximum of the profit go to the intermediary's pocket [12]. Khan [42] described several problems of fishermen and intermediaries in Mymensingh district, such as poor transportation, lower price of fish, lack of storage facilities, lack of weighing system, assessment of market tolls, lack of marketing facilities as well as political instability.

**Table 3. Constraints of fish markets in Sadar upazila of Jamalpur district**

| Constraints | Percentage (%) of respondent reported |
|---|---|
| 1. Infrastructure | 21 |
| 2. Unhygienic sanitary conditions | 18 |
| 3. Lack of capital | 14 |
| 4. Lack of icing facilities | 13 |
| 5. Low price | 10 |
| 6. Poor drainage facilities | 9 |
| 7. In-adequate water supply | 7 |
| 8. Higher transport cost | 3 |
| 9. Rough handling of fish | 3 |
| 10. Absence of toilet facilities | 2 |
| **Total** | **100%** |

*Source: Market Survey*

## 4. CONCLUSION AND RECOMMENDA-TION

Fish marketing plays a vital role in the economy of Bangladesh, which strengthens our food security and increases employment opportunities. The present study has been conducted to figure out the market behavior, supply chain, and logistic network of the fish in the Sadar upazila markets of the Jamalpur district of Bangladesh. The findings of the study reveal that the quality of the fish deteriorates along the supply chain due to the lack of applying adequate storage and handling methods. The price of the fish is positively correlated with quality. As the time spend in the market, the quality and the price of the fish decrease. Moreover, this study identified some problems that are the barrier of effective fish marketing as well as consumer's satisfaction. On the basis of the findings of this study, the following recommendations have been made for the improvement of existing fish market:

- Improvement of existing fish market infrastructure with all modern facilities.
- Establishment of improve drainage system where water can easily drain out.
- Improvement of sanitation, hygienic condition, and fish handling practices.
- Proper attention should be paid to the personal hygiene.
- Improvement of modern fish transport system where cool chain should be maintained in the vehicles during transportation.
- Financial and technical support should be given by Government and other organizations.
- Government should fix the commission of aratdars, so that they cannot charge unreasonable commission for their service.
- Establishment of ice factories for sufficient supply for fish preservation and should maintain the ice and fish ratio.
- Ensure pure water and toilet facilities as well as adequate water supply in the market for maintaining proper washing facilities.
- Ensure electricity by the authority.
- Providing training to the stakeholder on efficient fish marketing, handling, and storage to ensure modern and effective fish marketing system as well as its logistics.

## CONSENT

As per international standard or university standard, Participants' written consent has been collected and preserved by the author.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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# APPENDIX

## Table A1. Availability of fish species in the study location

| Sl. no | Scientific Name | English Name | Local Name | Water body | Availability in the Market |
|---|---|---|---|---|---|
| 1. | *Labeo rohita* | Rohu | Rui | FW | Frequent |
| 2. | *Catla catla* | Catla | Katol | FW | Frequent |
| 3. | *Cirrhinus cirrhosus* | Mrigal | Mrigal | FW | Frequent |
| 4. | *Ctenopharyngodon idella* | Grass carp | Grass carp | FW | Frequent |
| 5. | *Labeo bata* | Bata | Bata | FW | Frequent |
| 6. | *Cyprinus carpio* | Common carp | Common carp | FW | Frequent |
| 7. | *Labeo gonius* | Kuria labeo | Gonia | FW | Frequent |
| 8. | *Hypophthalmichthys molitrix* | Silver carp | Silver carp | FW | Frequent |
| 9. | *Labeo calbasu* | Orange-fin labeo | Kalibaus | FW | Frequent |
| 10. | *Pangasius pangasius* | Yellowtail catfish | Pangas | FW | Frequent |
| 11. | *Ompok pabda* | Pabdah catfish | Madhu pabda | FW | Frequent |
| 12. | *Oreochromis mossambicus* | Mozambique tilapia | Tilapia | FW | Frequent |
| 13. | *Oreochromis niloticus* | Nile tilapia | Nilotica | FW | Frequent |
| 14. | *Ompok bimaculatus* | Butter catfish | Kani pabda | FW | Frequent |
| 15. | *Clarias gariepinus* | North African catfish | African catfish | FW | Frequent |
| 16. | *Heteropneustes fossilis* | Stinging catfish | Shingi | FW | Frequent |
| 17. | *Anabus testudineus* | Climbing perch | koi | FW | Frequent |
| 18. | *Mystus bleekeri* | Day's mystus | Golsha-tengra | FW | Frequent |
| 19. | *Mystus vittatus* | Striped dwarf catfish | Tengra | FW | Frequent |
| 20. | *Channa punctata* | Spotted snakehead | Taki | FW | Frequent |
| 21. | *Pseudambassis baculis* | Himalayan glassy perchlet | Phopa chanda | FW | Less |
| 22. | *Puntius phutunio* | Spottedsail barb | Phutani puti | FW | Less |
| 23. | *Macrognathus aculeatus* | Lesser spiny eel | Tara baim | FW | Less |
| 24. | *Macrobrachium rosenbergii* | Giant freshwater prawn | Golda Chingri | FW | Less |
| 25. | *Tenualosa toli* | Toli shad | Chandana ilish | MW | Less |
| 26. | *Mystus gulio* | Long whiskers catfish | Nuna-tengra | FW | Less |
| 27. | *Mystus cavasius* | Gangetic tengra | Kabasi tengra | FW | Less |
| 28. | *Puntius chola* | Swamp barb | Chala punti | FW | Less |
| 29. | *Barbonymus gonionotus* | Java barb | Rajputi | FW | Less |
| 30. | *Puntius sarana* | Olive barb | Shorpunti | FW | Less |
| 31. | *Salmostoma bacaila* | Large razorbelly minnow | Chela/ Narkeli chela | FW | Less |
| 32. | *Rohtee cotio* | Cotio | Dhela | FW | Less |
| 33. | *Esomus danricus* | Flying barb | Darkina | FW | Less |
| 34. | *Labeo calbasu* | Orange-fin labeo | Calbaus | FW | Less |
| 35. | *Tenualosa ilisha* | Hilsa shad | Ilish | MW | Less |
| 36. | *Corica soborna* | Ganges river sprat | Kachki | FW | Less |
| 37. | *Ompok pabo* | Pabo catfish | Pabda | FW | Less |
| 38. | *Chanda nama* | Elongate glass-perchlet | Nama chanda | FW | Occasional |
| 39. | *Chitala chitala* | Humped featherback | Chital | FW | Occasional |

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| Sl. no | Scientific Name | English Name | Local Name | Water body | Availability in the Market |
|---|---|---|---|---|---|
| 40. | *Notopterus notopterus* | Bronze featherback | Foli | FW | Occasional |
| 41. | *Macrobrachium malcomsonii* | Monsoon river prawn | Chotka icha | FW | Occasional |
| 42. | *Penaeus indicus* | Indian white shrimp | Sada icha | FW | Occasional |
| 43. | *Puntius ticto* | Ticto barb | Tit punti | FW | Occasional |
| 44. | *Glossogobius giuris* | Tank goby | Bele | FW | Occasional |
| 45. | *Penaeus monodon* | Giant /Jumboo tiger shrimp | Bagda chingri | MW, BW | Occasional |
| 46. | *Gudusia chapra* | Indian river shad | Chapila | FW | Occasional |
| 47. | *Securicula gora* | Gora chela | Gora chela | FW | Occasional |
| 48. | *Amblypharyngodon mola* | Mola carplet | Mola | FW | Occasional |
| 49. | *Macrognathus pancalus* | Barred spiny eel | Pankal baim/Guchi | FW | Occasional |
| 50. | *Wallago attu* | Wallago | Boal | FW | Occasional |
| 51. | *Neotropius atherinoides* | Indian potasi | Batasi | FW | Occasional |
| 52. | *Chanda ranga* | Indian glass-perchlet | Lal chanda | FW | Occasional |
| 53. | *Puntius sophore* | Pool barb | Jat punti | FW | Occasional |
| 54. | *Mystus tengara* | Tengara mystus | Bujuri tengra | FW | Occasional |
| 55. | *Eutropiichthys vacha* | Batchwa vacha | Bacha | FW | Occasional |
| 56. | *Lepidocephalichthys guntea* | Guntea loach | Gutum | FW | Occasional |
| 57. | *Ailia coila* | Gangetic ailia | Kajuli/ Baspata | FW | Occasional |
| 58. | *Colisa fasciata* | Banded gourami | Boro kholisha | FW | Occasional |
| 59. | *Clarias batrachus* | Walking catfish | Magur | FW | Occasional |
| 60. | *Channa striata* | Snakehead murrel | Shol | FW | Occasional |
| 61. | *Xenentodon cancila* | Freshwater garfish | Kakila | FW | Occasional |
| 62. | *Pseudosphromenus cupanus* | Spiketail paradise fish | Koi | FW | Occasional |
| 63. | *Badis badis* | Badis | Napit koi | FW | Very rare |
| 64. | *Colisa lalia* | Dwarf gourami | Lal kholisa | FW | Very rare |
| 65. | *Setipinna phasa* | Gangetic hairfin anchovy | Phasa | FW | Very rare |
| 66. | *Bagarius bagarius* | Dwarf goonch | Baghair | FW | Very rare |
| 67. | *Mastacembelus armatus* | Zig-zag eel | Shalbaim | FW | Very rare |
| 68. | *Devario devario* | Sind danio | Banspata | FW | Very rare |
| 69. | *Clupisoma garua* | Garua bacha | Gang gaira | FW | Very rare |
| 70. | *Botia dario* | Bengal loach | Bou mach | FW | Very rare |
| 71. | *Sperata aor* | Long-whiskered catfish | Ayre/Air | FW | Very rare |
| 72. | *Acanthocobitis botia* | Mottled loach | Balichata | FW | Very rare |
| 73. | *Channa marulius* | Great snakehead | Gozar | FW | Very rare |
| 74. | *Nandus nandus* | Gangetic leaffish | Nodoi/ Veda | FW | Very rare |
| 75. | *Rita rita* | Bengal Catfish | Rita | FW | Very rare |
| 76. | *Labeo boggut* | Boggut labeo | Ghoria | FW | Very rare |
| 77. | *Sperata seenghala* | Giant-river Catfish | Guizza or Guizza Ayer | FW | Very rare |
| 78. | *Chaca chaca* | Square head catfish | Chaka or Gangania | FW | Very rare |

*Note: Prepared by the authors' based on the information from field survey. FW= Fresh Water, BW= Brackish Water, and MW= Marine Water*

**Table A2. Price Behavior of cultured fish**

| Fish Group | Fish species | Average Size of fish (kg) | Average selling prices by fisherman/ producer (Paid by wholesalers)Tk./Kg | Average selling prices by wholesaler (Paid by retailers) Tk./Kg | Average selling prices by retailer during different marketing time (paid by consumers)Tk./kg | | |
|---|---|---|---|---|---|---|---|
| | | | | | 9 AM to 12 PM | 12 PM to 3 PM | 3PM to 6 PM |
| Indian Major Carps | Rui | ≤ 1 | 140 | 144 | 200 | 170 | 150 |
| | | 1≤2 | 180 | 185 | 280 | 250 | 200 |
| | | 2≤ | 230 | 237 | 320 | 290 | 250 |
| | Catla | ≤ 1 | 120 | 124 | 180 | 160 | 140 |
| | | 1 to ≤2 | 160 | 165 | 230 | 200 | 175 |
| | | 2≤ | 200 | 206 | 280 | 250 | 215 |
| | Mrigal | ≤ 1 | 110 | 113 | 170 | 140 | 120 |
| | | 1 to ≤2 | 150 | 155 | 220 | 190 | 160 |
| | | 2≤ | 180 | 185 | 250 | 230 | 190 |
| | Bata | ≤ 1 | 110 | 113 | 150 | 140 | 120 |
| | Kalibaus | ≤ 1 | 120 | 124 | 180 | 160 | 130 |
| | | 1 to ≤2 | 150 | 155 | 230 | 200 | 160 |
| | Silver carp | ≤ 1 | 60 | 63 | 100 | 80 | 65 |
| | | 1 to ≤2 | 80 | 83 | 120 | 100 | 85 |
| | | 2≤ | 100 | 103 | 140 | 150 | 100 |
| | Grass carp | ≤ 1 | 100 | 103 | 130 | 135 | 110 |
| | | 1 to ≤2 | 140 | 144 | 170 | 180 | 150 |
| | | 2≤ | 180 | 185 | 240 | 230 | 190 |
| | Minor carp | ≤ 1 | 120 | 124 | 170 | 150 | 130 |
| | | 1 to ≤2 | 150 | 155 | 210 | 200 | 170 |
| | | 2≤ | 180 | 185 | 240 | 220 | 200 |
| | Common carp | ≤ 1 | 125 | 129 | 170 | 160 | 135 |
| | | 1 to ≤2 | 160 | 165 | 230 | 200 | 170 |
| | | 2≤ | 190 | 196 | 260 | 250 | 210 |
| | Bighead Carp | ≤ 1 | 85 | 88 | 130 | 110 | 95 |
| | | 1 to ≤2 | 110 | 113 | 160 | 140 | 115 |
| | | 2≤ | 130 | 135 | 210 | 190 | 170 |

| Fish Group | Fish species | Average Size of fish (kg) | Average selling prices by fisherman/ producer (Paid by wholesalers)Tk./Kg | Average selling prices by wholesaler (Paid by retailers) Tk./Kg | Average selling prices by retailer during different marketing time (paid by consumers)Tk./kg | | |
|---|---|---|---|---|---|---|---|
| | | | | | 9 AM to 12 PM | 12 PM to 3 PM | 3PM to 6 PM |
| Cat fish | Pangas | 0.50 to ≤ 1 | 65 | 68 | 100 | 95 | 80 |
| | | 1 to ≤ 2 | 80 | 83 | 120 | 115 | 100 |
| | | 2< | 95 | 98 | 140 | 130 | 110 |
| | Shing | <0.05 | 190 | 196 | 250 | 230 | 210 |
| | | 0.05< | 220 | 228 | 350 | 330 | 320 |
| | Magur | <0.2 | 200 | 206 | 320 | 300 | 280 |
| | | 0.2< | 240 | 248 | 350 | 330 | 300 |
| | Pabda | <0.05 | 160 | 165 | 260 | 200 | 180 |
| | | 0.05< | 190 | 196 | 300 | 240 | 220 |
| | Gulsha | <0.05 | 180 | 185 | 350 | 230 | 195 |
| | | <0.05 | 210 | 218 | 400 | 270 | 230 |
| Berbs | Sarpunti | 0.10 to ≤ 0.25 | 85 | 88 | 120 | 105 | 94 |
| | | 0.25 to ≤ 0.50 | 100 | 103 | 140 | 120 | 105 |
| | | 0.50< | 120 | 124 | 170 | 150 | 135 |
| Perch | Koi | <0.1 | 210 | 216 | 200 | 280 | 250 |
| | | 0.1< | 240 | 248 | 240 | 330 | 300 |
| Miscellaneous | Tilapia | 0.10 to ≤ 0.25 | 70 | 73 | 100 | 90 | 80 |
| | | 0.25 to ≤ 0.50 | 85 | 88 | 120 | 110 | 100 |
| | | 0.50< | 95 | 98 | 140 | 120 | 105 |

### Table A3. Price Behavior of captured fish

| Fish Group | Fish species | Average Size of fish (kg) | Average selling prices by fisherman/ producer (Paid by wholesalers)Tk./Kg | Average selling prices by wholesaler (Paid by retailers) Tk./Kg | Average selling prices by retailer during different marketing time (paid by consumers) Tk./kg | | |
|---|---|---|---|---|---|---|---|
| | | | | | 9 AM to 12 PM | 12 PM to 3 PM | 3 PM to 6 PM |
| Indian Major Carps | Rui | 0.85 | 170 | 180 | 250 | 220 | 200 |
| | Catla | 0.95 | 150 | 160 | 220 | 200 | 170 |
| | Mrigal | 0.78 | 160 | 170 | 210 | 200 | 175 |
| | Kalibaus | 0.66 | 140 | 150 | 210 | 195 | 170 |
| Catfish | Air | 0.9 | 355 | 370 | 500 | 470 | 430 |
| | Boal | 1.3 | 425 | 450 | 550 | 520 | 470 |
| | Baghair | 1.75 | 550 | 570 | 650 | 630 | 580 |
| | Bacha | 0.15 | 300 | 310 | 380 | 350 | 280 |
| | Rita | 0.1 | 270 | 290 | 400 | 350 | 310 |
| | Guizza | 0.1 | 270 | 280 | 450 | 400 | 360 |
| | Shing | 0.08 | 430 | 460 | 550 | 520 | 490 |
| | Magur | 0.25 | 520 | 550 | 600 | 580 | 550 |
| | Pabda | 0.035 | 340 | 360 | 460 | 425 | 380 |
| | Gulsha | 0.025 | 360 | 375 | 480 | 450 | 400 |
| | Batashi | 0.01 | 550 | 580 | 670 | 650 | 600 |
| | Kajuli | 0.045 | 410 | 430 | 580 | 520 | 440 |
| | Banspata | 0.02 | 450 | 470 | 650 | 600 | 520 |
| | Bujuri Tengra | 0.003 | 220 | 230 | 380 | 330 | 240 |
| | Tengra | 0.015 | 300 | 315 | 470 | 450 | 340 |
| | Baila | 0.07 | 380 | 400 | 480 | 470 | 450 |
| Berbs | Mola | 0.01 | 360 | 380 | 450 | 430 | 400 |
| | Dhela | 0.01 | 400 | 420 | 530 | 475 | 420 |
| | Chela | 0.015 | 365 | 380 | 490 | 450 | 400 |
| | Punti | 0.015 | 175 | 180 | 250 | 220 | 200 |
| | Tit punti | 0.005 | 155 | 160 | 200 | 180 | 160 |
| Perch | Chanda | 0.008 | 250 | 260 | 380 | 350 | 300 |
| | Khailsha | 0.025 | 330 | 345 | 480 | 420 | 360 |

| Fish Group | Fish species | Average Size of fish (kg) | Average selling prices by fisherman/ producer (Paid by wholesalers)Tk./Kg | Average selling prices by wholesaler (Paid by retailers) Tk./Kg | Average selling prices by retailer during different marketing time (paid by consumers) Tk./kg | | |
|---|---|---|---|---|---|---|---|
| | | | | | 9 AM to 12 PM | 12 PM to 3 PM | 3 PM to 6 PM |
| | Koi | 0.045 | 470 | 490 | 550 | 530 | 500 |
| | Gutum | 0.015 | 370 | 385 | 530 | 480 | 390 |
| | Chapila | 0.04 | 345 | 360 | 480 | 450 | 390 |
| | Kakila | 0.02 | 385 | 410 | 500 | 520 | 450 |
| Miscellaneous | Veda | 0.06 | 360 | 385 | 460 | 430 | 390 |
| | Bou mach | 0.01 | 340 | 355 | 550 | 515 | 475 |
| | Ilish | 0.3-0.7 | - | 500 | 600 | 580 | 560 |
| | | 0.7-1.0 | - | 615 | 800 | 790 | 780 |
| | | 1.0< | - | 760 | 970 | 950 | 930 |
| | Chandana Ilish | 0.5 | - | 370 | 450 | 420 | 380 |
| | Golda Chingri | 0.065 | 520 | 560 | 750 | 730 | 700 |
| | Bagda Chingri | 0.09 | - | 520 | 600 | 580 | 550 |

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