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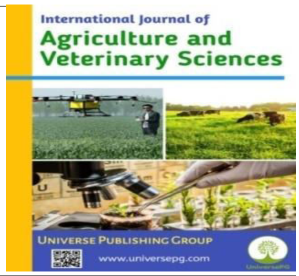

Impacts of COVID-19 on the Fish Market in Dinajpur District of Bangladesh

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ABSTRACT

This study interviewed 50 fish farmers and 50 retailers from Dinajpur district, Bangladesh to investigate the impacts of COVID-19 on the local fish market from a period of January to June 2023. The results showed that the fish culture costs including labor cost, feed cost and pharmaceutical costs increased significantly after COVID-19. Labor costs increased by 17-39%, feed costs by 41 to 45% and pharmaceutical costs by 30-31%. The prices of catfishes showed the highest change equal to BDT 288/kg whereas slightly reduced prices for pangas (BDT 68.6/kg), carps (BDT 101.72/kg) and tilapia (BDT 71.15/kg) were recorded. Retailers have increased the selling price (27-28%) of the pangas, tilapia, carp, and other fish species due to higher purchasing prices (32-40%) resulting in a squeeze on profit. The profit for pangas decreased to 11% post-COVID-19 from 22%, for tilapia from 21% to 11%, for carp profit decreased from 6% to 3% and for catfishes from 9% to 5% post-COVID-19. This study provides helpful information to minimize the unstable condition of fish markets and government and non-government organizations should intervene to mitigate the effects of COVID-19 with proper policy.

Keywords: COVID-19, Fish cost, Feed cost, Labor cost, Fish market, Farmers, and Retailer.

INTRODUCTION:

The coronavirus (2019-nCoV) was first reported in Wuhan, Hubei Province, China, on December 31, 2019 (WHO, 2020) which results a very serious infectious disease known as COVID-19 (Wang *et al*., 2020). The nature of this disease varies from other viral diseases, and it quickly spread in more than 210 countries and territories (Siche, 2020). The primary global health problem that is interfering with human life worldwide and affecting society's normal development is COVID-19 (Burnet and White, 1972; Anwar *et al.,* 2020). During this time, many countries are adopting different kinds of preventive measures such as mandatory lockdowns, social distancing, online business, work at home, and many types of restrictions applied in local and international travel (Loayza, 2020; Keshky *et al.,* 2020; Rafiquzzaman, 2020; Nicola *et al*., 2020).

The COVID-19 crisis also had an impact on the fisheries and aquaculture food systems economy, both directly and indirectly (Loayza, 2020; Amjath-Babu *et al*., 2020). Fish and fish products are food products that are traded extensively both globally and regionally all over the world (Belton *et al*., 2018) which have been significantly impacted by the usual supply chains' disruption (Glauber *et al*., 2020). The crisis had a severe effect on the fisheries sector in Asian countries, which are major producers of fish and fishery products, as well as major suppliers of fish to the global market which eventually resulted in delayed marketing (Amjath-Babu *et al*., 2020). The restriction measures have prevented fishermen from going out to the sources for fishing operations (Kaewnuratchadasorn *et al*., 2020; Abedin *et al*., 2020).

Bangladesh also faced various challenges due to the adverse effects of COVID-19 on its resources. As of August 1, 2021, the nation had 1,264,328 COVID-19 positive cases confirmed, 1,093,266 recovered cases, and 20,916 total deaths (Sunny *et al*. 2020). Bangladesh has confirmed 269,095 laboratory tested COVID-19 positive patients as of August 2020. Bangladesh reported 3557 (1.32%) deaths from 18 March 2020 until August 13, 2020.

The recovered patients in Bangladesh were 154,871 (57.55%) from COVID-19 and available patients under treatment 41.12% (110,667) until 13 August 2020 (Dey *et al.,* 2020). During COVID-19, Bangladesh government also imposed a lockdown which had an immense impact on everyone. Aquaculture being the second largest exporting section in Bangladesh also disrupted with fish production due to transportation restrictions which eventually impacted the trade, labor, feed and medicine costs. The implications of COVID-19 also had direct impacts on fish farmers, retailers and stakeholders (Sarafat, 2020; Samad *et al.,* 2022).

Although a few research works regarding the fisheries value chain and livelihood status of farmers during COVID restriction have been performed in Bangladesh, however, there is no specific report available on the impacts of COVID-19 on the fish market in Dinajpur district, Bangladesh. Therefore, this study focused on the different villages and fish markets of three upazilas in the Dinajpur district to investigate the effect of COVID-19 on fish farmers and retailers with special emphasis on fish production, market situation and economic viability. This study will help to draw attention to policymakers to provide support to aquaculture producers to mitigate the negative impacts of COVID-19.

MATERIALS AND METHODS:

Selection of the study area

The study area included three Upazilas of Dinajpur district in Bangladesh including Sadar, Birol, and Chirirbandor (**Fig. 1**). These were selected because they contribute substantially to freshwater aquaculture production. The study area also included different types of big fish markets including Bahadur bazar, Railbazar, Pachbari bazar, Ambari bazar in Dinajpur district where all types of fishes are available. The survey was conducted for six months from January to June 2023 to collect the data from the selected farmers and retailers in the study area.

Target groups

To get the expected achievement from the study, hundred (100) questionnaires were prepared (50 questionnaires were for fish farmers and the other 50 questionnaires were for retailers) during the experiment. The target groups included fish farmers who are involved in fish farming and retailers who work in fish markets in the study area.

Data Collection

A set of preliminary questionnaires was prepared for face-to-face interviews. The questionnaire was divided into mainly two sections after making necessary corrections and modifications. In the first section, data were collected from farmers and in the second section, data were collected from retailers.

All types of questions were related to pre-and post-COVID-19 conditions and also keeping the objectives of the study in mind. Numerous qualitative techniques, including oral history, key informant interviews with informed individuals, and individual interviews were used to gather the data.

Data processing and analysis

After data collection, questionnaire data were edited and entered into a Microsoft Excel spreadsheet. Primary analysis such as descriptive, graphs etc. was carried out using Microsoft Excel. Results were expressed as mean ± standard deviation (SD).

The data were analyzed using SPSS for Windows version 20, IBM and subject to Shapiro-Wilk's and Levene's test for confirming normality and homogeneity of variances respectively. Student *t*-test was performed to determine the differences between pre- and post-COVID-19 impacts at a 5% level of significance.

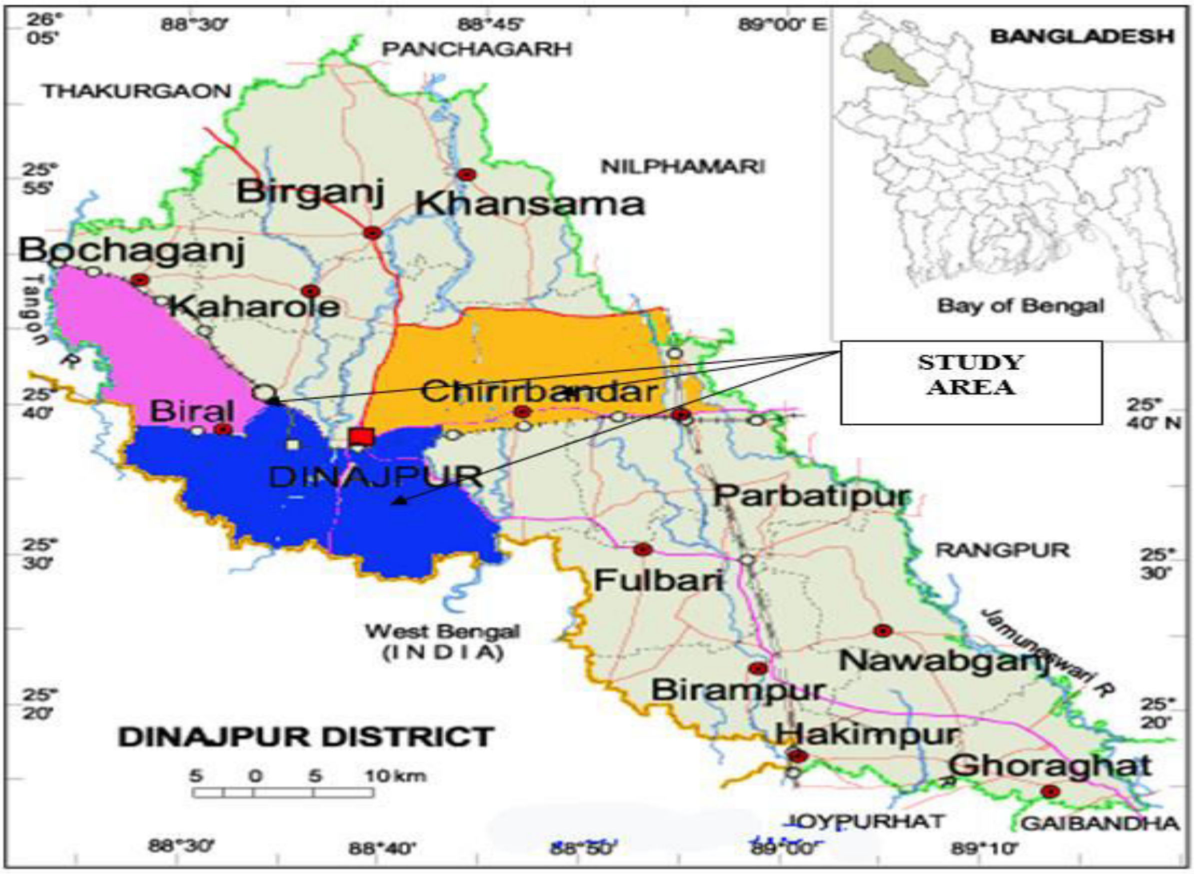

Fig. 1: Map of the study area.

RESULTS AND DISCUSSION:

Farmer-related information

Farm size

Farmers in the study area have different sizes of farms for fish culture. Farm size is categorized into four types based on the sizes. This study found that 70% of farmers have farms within 1-100 decimal, followed by 15% within 101-200 decimal, 7.50% within 201-300 decimal and 7.50% within 301-400 decimal (**Table 1**). A study of different areas found that fish species are cultured in different sizes of farm such as small within 34.28 decimal, medium within 93.65 decimal and large farm size within 142.50 decimal (Aktar *et al.* 2018). In a study, Roy *et al.* (2002) found that the majority of fish farmers (57%) had a culture area of up to 5 hectares, followed by 25% with farms of between 5 and 10 ha and about 18% with farms larger than 10 ha. Therefore, the farm size varies according to the region.

Table 1: Percentage of the farm size in the study area.

Farm Size (decimal)	Percentage of respondents
1-100	70.00
101-200	15.00
201-300	7.50
301-400	7.50

Cultured species

Farmers in the study area cultured different species including pangas, tilapia, carp, and catfishes. The percentage of cultured different types of species varies pre- and post-COVID-19 conditions. However, the study revealed that 67.5% of the farmers cultured pangas pre-COVID-19 which increased to 80% post-COVID-19. Similarly, tilapia culture increased from 72.5% to 82.5%; carp 87.5% to 100% and catfishes from 62.5% to 70% pre-and post-COVID-19 respectively (**Table 2**). Mandal *et al.* (2021) reported that during the pandemic, common fish found in urban markets included pabda catfish, pangas, tilapia, Indian major carps, shrimp/

prawns, and climbing perch and 10-20% of respondents reported that tilapia and Indian main carp were unavailable during COVID.

Table 2: Cultured species pre- and post-COVID-19 in the study region.

Culture species	Pre- COVID-19 (%)	Post- COVID-19 (%)
Pangas	67.50	80.00
Tilapia	72.50	82.50
Carp	87.50	100.00
Catfishes	62.50	70.00

Labor engagement

Farmers stated that they needed different types of labor for fish farming including permanent labor, seasonal labor, and non-aquaculture labor. The percentage of labor requirements has decreased post-COVID-19 compared to pre-COVID-19. In the study area, farmers mainly employed seasonal labor about 6.55% in pre-Covid-19, though the percentage decreased to 5.05% in post-Covid-19. For permanent labor, the percentage also decreased from 2.93% to 2.31%, and for non-aquaculture labor, the percentage decreased from 3.2% to 1.63% pre- and post-COVID-19 respectively (**Table 3**). Similarly (Hasan *et al.,* 2021) reported that farmers reduced the number of laborers due to COVID restrictions from 209 to 149 in the Mymensingh district of Bangladesh. This indicated that COVID-19 restrictions were subjected to unemployment in the aquaculture sector. On the other hand, Bhanja *et al.* (2023) reported that over 50% of fish workers were migrants and not available locally because most of them went to their home states and lost their jobs. The authors stated that before COVID-19, there was 18% of labor worked in the farm while it reduced to 10% after COVID.

Table 3: Types of labor engagement pre- and post-COVID-19 in the study region.

Types of labor	Pre- COVID-19 (%)	Post- COVID-19 (%)
Permanent labor	2.93	2.13
Seasonal labor	6.55	5.05
Non-aquaculture labor	3.20	1.63

Labor cost

Labor cost and the number of labors also play a significant role in successful fish production. The labor cost in the study area was also impacted by COVID-19. The highest increase was seen for seasonal labor where the cost rose significantly post-COVID-19 by 39% (BDT 191.25 per day; $P<0.001$). In addition, a small but significant increase in labor cost was also found for permanent labor (BDT 87.50 per day; $P<0.001$) where an increase of 17% in labor payment occurred. Similarly, there was a significant increase of about 31% in the unit labor cost for non-aquaculture labor (BDT 61.25 per day; $P<0.001$) (**Table 4**). Hassan *et al*. (2021) reported that the daily average labor cost decreased by more than 10%. They found the largest reduction for non-technical personnel, whose costs decreased dramatically by 16.4%. Conversely, a somewhat noteworthy reduction in labor expenses was noted for seasonal employees, with an 11.4% drop in costs.

Table 4: Labor cost in the study area during pre- and post-COVID-19.

Types of labor	Pre-COVID-19 (BDT/day)	Post-COVID-19 (BDT/day)	*t-value*	% Change
Permanent labor	360.00 ± 45.74	421.25 ± 52.97	-5.54[a]	17
Seasonal labor	487.50 ± 121.82	678.75 ± 127.04	-6.87[a]	39
Non-aquaculture labor	282.50 ± 87.49	370.00 ± 81.49	-4.63[a]	31

Note: "a" indicates the significant difference at 1% level pre- and post-COVID-19

Feed costs

All farmers in the study area experienced an increase in feed costs due to COVID-19. The results represented significantly increased production costs per kg of BDT 22.93 ($P<0.001$), 21.09 ($P<0.001$), 22.22 ($P<0.001$), and 21.71 ($P<0.001$) for pangas, tilapia, carp, and catfish production respectively. On average the feed costs were increased to 45% for pangas, 41% for tilapia, 43% for carp, and 42% for catfishes (**Table 5**). In accordance with our study, Hassan *et al*. (2021) surveyed that the COVID-19 pandemic increased feed costs for almost all farms. The feed cost increases for tilapia were 7.43% on average, pangas were 6.70%, other catfish were 8.25%, and carps were 11.3%. Alam *et al.* (2023) found that there was a spike in the prices of key fish feeds, including BDT 45, BDT 35, BDT 30 and BDT 22 per kg for rice break, khail, and wheat dust, respectively due to the epidemic. The prices of feed increase may be due to a lack of raw materials.

Table 5: Feed cost of different cultured fish species in the study area.

Cultured fish species	Pre- COVID-19 (BDT/kg)	Post- COVID-19 (BDT/kg)	*t-value*	% Change
Pangas	50.47 ± 3.32	73.40 ± 5.46	-19.670[a]	45
Tilapia	50.91 ± 3.62	72.00 ± 5.81	-17.716[a]	41
Carp	50.98 ± 3.77	73.20 ± 5.79	-20.368[a]	43
Catfishes	51.59 ± 4.08	73.30 ± 6.29	-15.039[a]	42

Note: "a" indicates the significant difference at 1% level pre- and post-COVID-19

Pharmaceutical costs

This result revealed that the farmers' payment for pharmaceuticals was increased post-COVID-19 to continue their culture for all types of culture species in the study area. The significant increase in pharmaceutical costs was BDT 10.53 per kg for pangas (P<0.001), BDT 10.94 per kg for tilapia (P<0.001), BDT 11.02 per kg for carp (P<0.001), and BDT 10.45 per kg for catfishes (P<0.001). The percent change of pharmaceutical costs had very little difference between the culture species. The results depicted 31% for tilapia and carp whereas it was 30% for pangas and catfishes (**Table 6**). Similar results were reported by Hassan *et al*. (2021) and they found it was 15.4% (BDT 3061 per hectare), for pangas, 6.87% (BDT 1600/hectare) for tilapia, 8.17% (BDT 3538/hectare) for carp, and 6.92% for other catfish (BDT 3286/hectare).

Table 6: Pharmaceutical cost of different cultured fish species in the study area.

Cultured fish species	Pre- COVID-19 (BDT/kg)	Post- COVID-19 (BDT/kg)	*t-value*	% Change
Pangas	35.27 ± 4.83	45.8 ± 5.73	-7.699[a]	30
Tilapia	35.06 ± 4.62	46.00 ± 4.96	-9.279[a]	31
Carp	35.23 ± 5.07	46.25 ± 5.99	-8.891[a]	31
Catfishes	35.00 ± 5.15	45.45 ± 5.45	-7.246[a]	30

Note: "a" indicates the significant difference at 1% level pre- and post-COVID-19

Price of fishes

The results showed that the price of all types of cultured species has significantly increased post-COVID-19 (**Table 7**). The biggest significant increase was observed for catfishes which rose by 72% and equated to a mean difference of BDT 288/kg (P<0.001). Similarly, the mean price of carp and tilapia significantly increased following COVID restrictions by BDT 101.72/kg (P<0.001) and BDT 71.15/kg (P<0.001) respectively. This represented the percent change in the price of carp and tilapia was 52% and 59% respectively. However, a small margin was found for pangas compared to other fish species, and the price was increased by 68% equated to BDT 68.6/kg (P<0.001) (**Table 7**). Mitra *et al.* (2022) revealed that the cost of many cultivated and catch fish species, including pangas, bayeem, boal, shoil, ayr, and taki, dramatically decreased during COVID-19, whereas the price of catla, mrigal, common carp, mola, tengra, and shing increased. Bhanja *et al.* (2023) reported that during COVID, the farm gate price of carp and catfish increased by 20-40% in Bihar, West Bengal, and Assam. Transport restrictions resulted in a complete cessation of fish supplies from other states, which drove up fish prices by 25–40% compared to the pre-lockdown era. Similarly, Alam *et al.* (2023) reported that silver carp, common carp, grass carp, and tilapia fish were sold at the farm gate for BDT 80, BDT 130, BDT 150, and BDT 100 per kilogram prior to the pandemic. Following COVID-19, the rates per kg were BDT 80, BDT 125, BDT 140, BDT 120, and BDT 90, in that order. Mandal *et al.* (2021) observed that about 28% of respondents stated that fish prices had reduced in some locations during the pandemic, whereas roughly 72% of respondents stated that fish prices had climbed throughout the epidemic. The mean costs per kg for pangas, tilapia, rohu, and catla were 3.2, 3.34, 1.48, and 1.5 USD respectively.

Table 7: Price of fish pre- and post-COVID-19 in the study area.

Cultured fish species	Pre- COVID-19 (BDT/kg)	Post-COVID-19 (BDT/kg)	*t-value*	% Change
Pangas	101.31 ± 9.98	169.91 ± 16.84	-19.46[a]	68
Tilapia	120.31 ± 16.25	191.46 ± 31.92	-11.41[a]	59
Carp	192.78 ± 62.00	294.50 ± 80.48	-6.33[a]	52
Catfishes	401.38 ± 43.59	690.35 ± 45.92	-24.58[a]	72

Note: "a" indicates the significant difference at 1% level pre- and post-COVID-19

Factors change in fish price from farmer perception

The factors behind increasing fish price post-COVID-19 stated by farmers. The highest respondents about 92% stated less demand for fish might be due to the low income. However, 87% of farmers agreed to increase labor and transportation cost, 82% less import, 75% increase of feed cost, 67% ice price increase, and 62% current charge increase (**Fig. 2**). Several authors reported that the increased electricity cost, labor cost, feed cost and transportation costs were the reasons for increasing overall fish price (Hasan *et al.,* 2021; Samad *et al.,* 2022; Khan *et al.,* 2023).

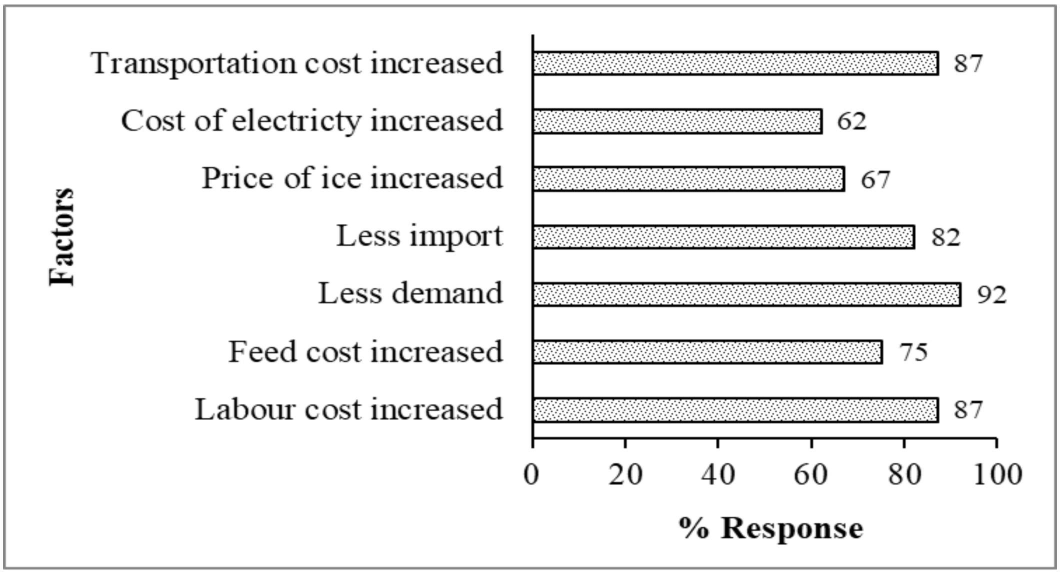

Fig. 2: Factors change in fish price pre- and post-COVID-19.

Retailer-related information

Input cost

The result showed that the purchasing cost of all types of cultured species by retailers has significantly increased post-COVID-19. The cost of fish purchased has increased for pangas BDT 43.38/kg (P<0.001) on an average of 40% post-COVID-19. On the other hand, retailers purchased tilapia with a significantly increase amount of BDT 48.38/kg (P<0.001) on average 39%, carps with BDT 70.75/kg (P<0.001) on average 33%, and catfishes with BDT 118.25/kg (P<0.001) on average 32% post-COVID-19 (**Table 8**).

Table 8: Changes in fish price by retailers pre- and post-COVID-19.

Cultured fish species	Pre-COVID-19 (BDT/kg)	Post-COVID-19 (BDT/kg)	*t-value*	% Change
Pangas	108.75 ± 15.88	152.13 ± 19.84	-10.79[a]	40
Tilapia	122.13 ± 18.84	170.50 ± 31.19	-8.39[a]	39
Carp	217.50 ± 49.71	288.25 ± 60.93	-5.69[a]	33
Catfishes	367.50 ± 58.34	485.75 ± 71.39	-8.11[a]	32

Note: "a" indicates the significant difference at 1% level pre- and post-COVID-19.

Purchasing cost pre- and post-COVID-19 of fish has changed from before for pangas 40%, for tilapia 39%, for carps 33%, and for catfishes 32%. In a study Mandal *et al.* ((2021) observed that the percentage dropped to 45% during the pandemic.

Output cost

The results showed that the selling costs have risen for both pangas and catfish nearly 27%, corresponds to BDT 35.62 per kg for pangas (P<0.001) and for catfishes BDT 108.5 (P<0.001) per kg. Same trend was observed for the tilapia and carp with a 28% increase, for tilapia increase (BDT 42/kg, P<0.001) and for carp increase (BDT 65/kg, P<0.001) (**Table 9**). Hassan *et al*. (2021) found that between pre- and post-COVID, the percentage of customers purchasing fish fell from 46.7% to 30%.

Table 9: Changes in fish price by retailers pre- and post-COVID-19.

Cultured fish species	Pre-COVID-19 (BDT/kg)	Post-COVID-19 (BDT/kg)	*t-value*	% Change
Pangas	132.63 ± 24.47	168.25 ± 24.69	-6.48[a]	27
Tilapia	147.5 ± 18.22	189.50 ± 18.81	-10.15[a]	28
Carp	231.38 ± 48.40	296.38 ± 60.75	-5.29[a]	28
Catfishes	399.25 ± 32.76	507.75 ± 53.08	-11.06[a]	27

Note: “a” indicates the significant difference at 1% level pre- and post-COVID-19

Profit of retailers

Profit of retailers before to post-COVID-19 conditions has changed. The results showed that profit of retailers sharply decreased post-COVID-19. The profit for pangas decreased to 11% post-COVID-19 from 22% pre-COVID-19. Similarly, the profit for tilapia was higher about 21% pre-COVID restriction which became 11% post-COVID whereas for carp profit changed from 6% to 3% and for catfishes from 9% to 5% post-COVID-19 (**Fig. 3**). Hassan *et al.,* (2021) found that the sales prices of tilapia and other catfish were decreased after COVID-19, although the level of decrease was less than that observed by the consumer. Pangasius and other catfish were the most affected fish species with a drop of mean revenue of BDT 10.5/kg for pangasius and BDT 33.1/kg for other catfish whereas for carp was BDT 13.3/kg.

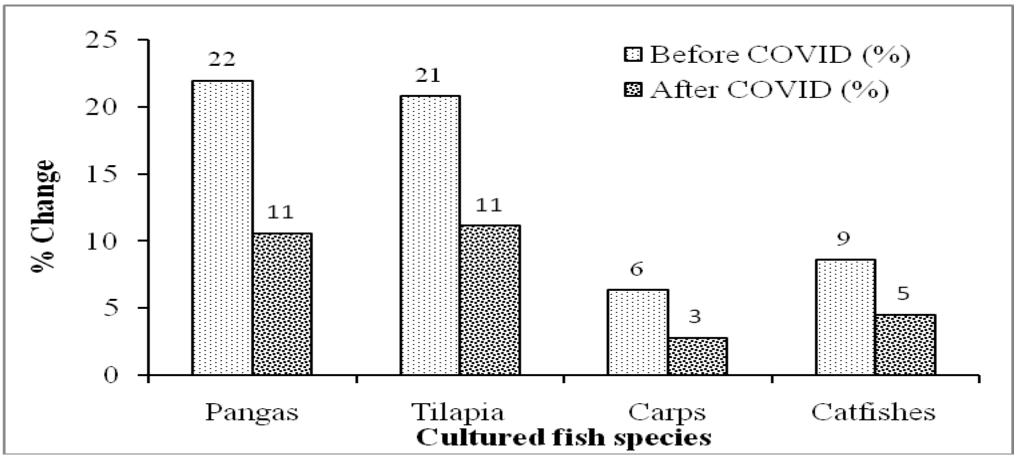

Fig. 3: Profit of retailers pre- and post-COVID-19 situations.

Factors change in fish price from retailer perception

From the current study majority of farmers, almost about 87% stated increased low income, followed by 85% increased feed cost, 82% low demand, 75% price of ice increase, 75% increase of other raw materials cost, 67% cost of electricity increase, 62% less import, increase of transportation and labor cost post-COVID-19 (**Fig. 4**). Siddiqua *et al.* (2022) revealed that 59% of respondents reported reduced transportation rates for the higher price of fishes. Other reported reduced rates of fish consumption, changes in feeding habits, unavailability of fish and fry stocking problems due to COVID restrictions could be the reasons for the increase in fish prices (Samad *et al.,* 2022).

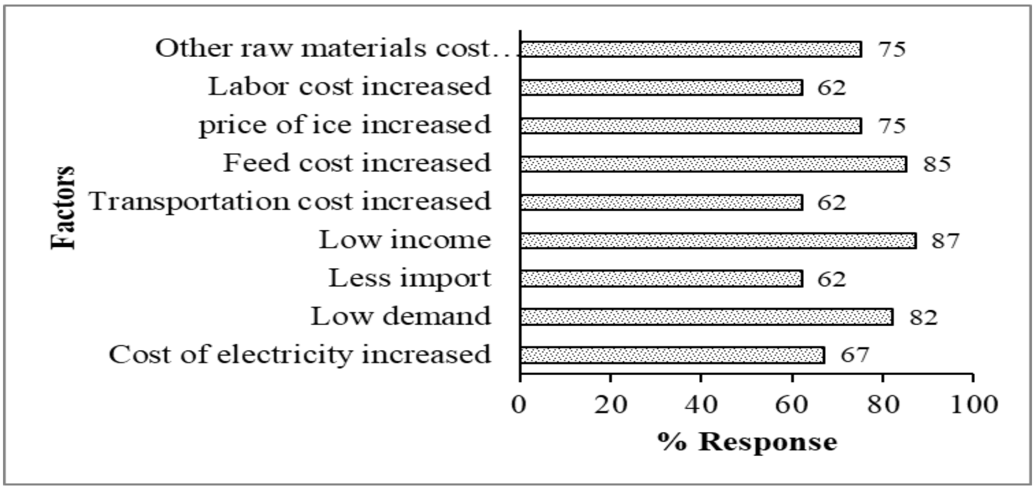

Fig. 4: Factors change in fish price pre- and post-COVID-19.

CONCLUSION:

The worldwide pandemic COVID-19 has affected the economy of almost every country particularly developing countries like Bangladesh. COVID-19 had a severe impact on the fish farmers and personnel related to aquaculture and fish markets in Bangladesh, putting them down below the poverty or even extreme poverty level. This study reveals the status of market prices of cultured fish species pre- and post-COVID-19. Our study found that the cost to run aquaculture activities including feed costs, pharmaceutical costs and labor costs increased after COVID-19 in the study area which ultimately narrowed down the profit margin of farmers and retailers. As a result, farmers and retailers are planning to switch their professions. Therefore, government and non-government organizations should come forward to take the necessary steps to combat the negative effects of COVID-19 in the aquaculture sector.

ETHICAL CLEARANCE:

The research was conducted in accordance with the Ethics Committee of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

AUTHORS CONTRIBUTION:

A.M.J. Data collection, Analysis and interpretation of results, and Manuscript preparation; F.R.N. Data collection, Manuscript writing and review; M.K.A. Data collection, Manuscript writing and review; M.N.A. Study conception and design, Manuscript review N.G. Study conception and design, Analysis and interpretation of results, Manuscript writing and review.

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CONFLICTS OF INTEREST:

The authors declare that there is no potential conflict of interest.

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