Journal of Advanced Zoology

ISSN: 0253-7214

*Volume **44** Issue -5 **Year 2023** Page **1652-1665***

A Qualitative Study On Post-Harvest Fish Management And Its Associated Parameters, Including Its Impact On The Personal, Social And Economic Security Of Fish Traders In Three Busiest Fish Markets Of Bongaon Municipality, West Bengal, India

Sejuti Roy[1], Niladri Sekhar Das[1*], Tahseen Alam[1], Dipsikha Ghosh[1], Shubhajit Saha[2]

[1]Department of Zoology, Dinabandhu Mahavidyalaya, Bongaon, West Bengal, India*
[2]Department of Zoology, The University of Burdwan, Purba Barddhaman, West Bengal, India
e-mail: SR, snahabiswas@gmail.com; NSD, bioniladri@gmail.com; TA, tahseenalam9@gmail.com; DG, dipsikhaghosh@yahoo.com; SS, ssaha@zoo.buruniv.ac.in

***Corresponding Author:** Niladri Sekhar Das*
Email: bioniladri@gmail.com

Abstract

A preliminary survey was conducted in the local fish markets of Bongaon to study and document the basic knowledge and awareness of fish traders about the post-harvest preservation of fish. As a large percentage of the fish traders are either illiterate or less educated and are not aware of the actual preservation techniques, proper hygiene and bacterial preservation procedures are not maintained in most of the cases. Three popular fish markets in Bongaon, namely New Market, Netaji Market, and Taw Bazar were surveyed by giving a structured questionnaire (Yes/No type) about post harvesting techniques and fish market economy to the fish sellers. It was found that though they all are confident about nutritional value and quality and post-harvest care of fish, they have a limited idea about the main cause of spoilage and the huge economic loss for negligence of the hygiene matter. Most of the responses from Netaji market and new market came similar except a few points like market`s infrastructure, healthy environment and administrative co-operation. Rather the responses from Taw bazar were slightly different about the preservation procedures. Regarding money savings, banking is the most popular choice, but some also rely upon post office and insurance. However, the study clearly revealed the status of general awareness among the fishmongers about the all over maintenance of hygiene and proper preservation procedures after harvesting of fishes.

Keyword: Fish Management; nutritional value; post harvesting; hygiene; preservation; fish market

Introduction

India is the world`s third largest fish producer, accounting for 7.96% of global production. In the fiscal year 2022-2023, the country`s total fish production is estimated at 16.25 million metric tons, with 7% average annual

growth (Annual Report, 2022-2023, Govt. of India, Dept. of Fisheries). The fisheries sector contributes 1.09% to the total GVA (Gross Value Added) and 6.72% to agriculture GVA, playing a significant role in the national economy (Annual Report, 2022-2023, Govt. of India, Dept. of Fisheries). Approximately 14 million people are involved in fisheries and related activities in India (National fisheries Development Board). With the rapidly growing population in India, it is essential to store and transport the fishes from one place to another retaining its proper nutritional values for consumption. Therefore, a proper quality preservation technique is necessary to prevent microbial spoilage without hampering its nutritional quality. As fish is rich in first-class proteins, essential fatty acids including omega 3 fatty acid, vitamins, micronutrients and minerals; fish is the main source of all necessary nutrients in Low Income Food Deficit Countries (LIFDCs) like India. Fish is an important and cost-effective source of animal proteins for local people in both developed and developing countries (Adewolu and Adeoti, 2010) Although the demand for fresh fish is the highest in our country and around 70% of harvested fish is marketed as fresh (Department of Animal Husbandry, Dairying & Fisheries Ministry of Agriculture & Farmers Welfare Government of India, 2017) we have to rely on preserved fish to meet the increasing demand of this huge population. But the biggest problem is that if the fish is not stored properly, the fish rots easily due to bacterial infection, which causes huge economic losses in our country every year (Mohan, 2020). As spoilage of fish begins as soon as it is caught (FAO, 2005) proper storage, preservation and prompt transport services are essential. Post-harvest preservation of fish in this country is largely neglected due to technical weakness, lack of proper infrastructure, and lack of expert consultants to protect fish from decay which is even augmented during monsoon. To increase economic returns for those dependent on the fishery without increasing fishing effort, it is vital to strengthen post-harvest infrastructure and establish an effective marketing network in identified areas and this will ensure higher profit, promote quality assurance and better nutritional quality for fish consumers.

Fisheries in our country mainly divided into two broad categories: cultured fisheries and captured fisheries. Both are important to meet the growing demand of fish among this large population of our country. Unfortunately, most of the fish markets, both wholesale and retail, in the country are in poor condition. A large volume of fish is sold through street markets, often on footpaths close to open drains. Sometimes buildings are erected as fish market but the internal environment and sanitation system of these buildings are not hygienic at all. This unhygienic environment, combined with the fact that fish is mostly kept on ice, leads to rapid deterioration in the quality of fish. Furthermore, the standard norms of hygiene and sanitation are not adequately considered during marketing, transportation, or storage of fish, resulting in a product that is contaminated and unsafe from a food safety point of view.

On the other hand, most of the fish traders and stakeholders are generally illiterate or less educated and may lack the necessary knowledge and expertise for properly handling fish after it has been harvested. Ignorance of stakeholders and degraded environmental condition of fish market is associated with unhygienic handling and fish processing, for which they have to face a huge economical loss. Every year 25% gross agricultural and fishery products are spoiled due to chemical degradation, enzymatic decay and microbial decomposition (Baird-Parker, 2000). The amount of microbial degradation of fish is not less than 30% of gross production (Amos, 2007) for this degradation, the responsible factors are digestive enzymes, lipases, activity of surface bacteria and oxidation of biomolecules like lipids (AMEC., 2003). In countries like India, where the ambient temperature is high, the decaying process known as rigor mortis starts within 12 hours after the fish is caught. (Berkel, et al., 2004). During spoilage of fish through the breakdown of different components several other components are formed which alter the texture, taste, odor, and nutrition quality of consumable fish, of which few may be toxic health hazard chemicals like biogenic amines (Silla-Santos, 1996, ten Brink, et al., 1990). Biogenic amines can cause nausea, diarrhea, itching, rash, abdominal pain, headache etc (Shalaby, 1996). During long storage time and processing the higher temperature may cause the formation of biogenic amines like histamines in food products including fish (Luten, et al., 1992).

A current trend of illegal practice in fish preservation is the use of formalin to prevent decomposition of fish. Mainly during the import of large sized fish some countries or states face this problem. In Hongkong, China, Sri Lanka, Tanzania, Indonesia, Ghana indiscriminate use of formalin to preserve fish is a matter of great concern for the physical safety of the people of the country (Aminah et al., 2013, Goon et al., 2014). The government of Assam has stopped imports from Andhra Pradesh into its state for preservation by formalin. (Prithvijit Mitra, 2018). The use of formalin is surreptitiously increasing in West Bengal as well. Eating formalin-preserved fish increases susceptibility to hepatic necrosis and cancer as International Agency for Research on Cancer has announced formalin as Group I carcinogen (IARC, 2004). If the fish is left in the formalin solution for 3-4 hours, the amount of formalin that enters the fish tissue cannot be washed out. Several

studies have shown that formalin is present in high levels in imported freshwater fish in Bangladesh, but negligible in local small fish (Hossain et al., 2008).

Bongaon (23.07°N 88.82°E) is a beautiful town located by the side of the Ichhamati river. It is a municipality area in the North 24 Parganas district in the state of West Bengal, India. Bongaon serves as the headquarters of the Bongaon subdivision. The Bongaon Municipality has a population of 108,864, with 55,382 males and 53,482 females, according to the Census India 2011 report (Bongaon Town Population Census. Link: https://www.census2011.co.in/data/town/801691-bongaon-west-bengal.html). The literacy rate in the area is 89.70%. It is not only a well-connected town through railway and road transport with Kolkata, but also economically important being present at the periphery of India-Bangladesh International Border. Among the various fish markets scattered throughout the town, only three are popular: New Market, Netaji Market, and Taw Bazar. About 75-80 fishmongers earn their livelihood by selling fish here. The freshwater inland fishes are brought to these three fish markets from various places, including the villages, and sold as fresh, mostly preserved in ice, to the consumers.

The primary goal of this study is to examine the three main fish markets of Bongaon Municipality. It aims to assess the awareness and knowledge of fish traders regarding post-harvest processing, preservation, and handling of fish to prevent spoilage, as well as their personal hygiene, social security, and the availability of municipal facilities. The purpose of this work is also to raise awareness among local governing bodies, organizations, and institutions, enabling them to improve the knowledge and skills of fish traders through financial support and conducting short-term training and awareness programs.

Method:

The three large as well as busiest fish markets of Bongaon Municipal area namely Taw Bazar, New Market and Netaji Market had been selected for this survey, as a large portion of the people of the municipality came here to do their market every day. Each fish trader in the three markets was asked a set of questions prepared in a specific way and the answers obtained were not disclosed to anyone else and used strictly for academic purposes only. These questions were put to 32 fishmongers in Tao Bazar, 30 in New Market and 15 in Netaji Market but 26 fishmongers in Taw Bazar, 24 in New Market and 12 in Netaji Market (total 62) answered the questions properly, the rest did not want to answer due to personal reasons. A questionnaire **(Table 1)** containing relevant questions was prepared for this purpose. None of the questions were descriptive, and were answered with 'YES' or 'NO' keeping in mind their limited knowledge and valuable time. The questions were mainly divided into three main sections. The first section was composed of 20 sequential questions mainly about the perception of fish traders regarding fish spoilage, post-harvest fish management and preservation, chemical preservation and its effect on consumers, way to keep fish as well as personal hygiene well, assessment of quality of fish for consumption, susceptibility to microbial attack, synthesis of harmful organic molecule due to unscientific preservation procedures, introduction of short-term curriculum in various levels of educational institutions related to post-harvest conservation etc. Only those who answered 'YES' to question 9 were asked additional three questions 9a, 9b and 9c. The second section of questions containing 8 questions evaluates their opinion and knowledge regarding the contribution of fisheries sector to the improvement of the country's economy and GDP, existing infrastructure and supportive environment in the market, feasibility of communication system etc. The third section contains 11 questions mainly on the social and economic security of the fishmongers. The interviewers patiently read out the questions in very simple regional language to the fish traders while asking questions, if anyone had difficulty understanding the questions, the questions were clarified and re-explained.

The 'YES' and 'NO' answers obtained from each respondent have been converted into percentages for convenience of graphical representation. These percentage values of ‘YES’ obtained from the three fish markets are expressed in bar diagrams (**Figure 7, 8**) to facilitate comparative discussion. During interpretation of data negative answers were not be considered and only ≥50% response value of ‘YES’ would be considered as significant.

Sl.No.	Questions
First Section: Questions Regarding Post-Harvest Management and Preservation	
1	Do you know that fish are highly perishable and susceptible to spoilage if not stored correctly at home?
2	Do you know that the main components of Fish are proteins and fats?
3	Do you know the main sources of our proteins are fish?

4	Do you consider post-harvest fish handling operations to be equally significant as the total fish yield?
5	Do you know that post fish harvest loss contributes about billions of rupees annually?
6	Do you know that fish spoilage occurs primarily due to the degradation of proteins and lipids?
7	Are you aware that excessive watering on fish can enhancing the degradation of their quality, leading to spoilage?
8	Are you aware that there exist numerous fish preservation techniques beyond just icing and chilling?
9	Do you know about the formalin preservation method of fish?
9a	Do you identify the fishes whether they are preserved with formalin or not?
9b	Are you aware about the fact that formalin is used to preserve only dead bodies for long term preservation?
9c	Do you know consumption of formalin along with fish may cause serious illness?
10	Are you aware that consuming spoiled fish is unhealthy and not safe for human consumption?
11	Do you think your preservation procedure is enough for healthy fish marketing?
12	Do you think spoilage of fish be reduced by implementing proper fish handling techniques and maintaining hygienic practices?
13	Do you think communication from whole sale fish market to local fish market is good enough for fast carriage without any chance of starting spoilage?
14	Do you believe that individuals involved in post-harvest fish activities such as storage, transportation, market selling, processing, etc., should possess specialized knowledge and maintain a professional demeanor?
15	Would the introduction of a comprehensive program focused on "Post Harvest Fish Management," encompassing tasks like handling, hygiene (both for fish and personnel), transportation, storage, quality assessment, and more, be beneficial for you?
16	Do you think a short-term course on Post-harvest Preservation of fish should be conducted regularly with the help of institutions like College, University etc.?
17	Do you think, proper school education is necessary to handle the fish problems?
Second Section: Questions Regarding Infrastructure, Communication System, Contribution in Indian Economy, Health, and hygiene	
A	Do you believe that the fish market possesses adequate physical infrastructure and is thriving?
B	Do you think the atmosphere surrounding you is healthy enough?
C	Do you think, fish market should be separately placed and away from the vegetable market for maintaining proper hygiene?
D	Do you think the initiatives undertaken by local governing bodies to establish optimal fish markets and upkeep existing ones are sufficient?
E	Are you aware that the fish sector in our country employs approximately 14 million people?
F	Are you aware with, fishery sector is one of the major contributors in country's total GDP?
G	Do you know that apart from consuming fresh fishes, the fishes are also used for production of manure, ornaments, home décor, biscuits etc.?
H	Should fishery sector be treated as industry?
Third Section: Questions Related with Social and Economic Security	
I	In which day do you earn more?
II	During which season your income is increased?
III	Do you have any life Insurance?
IV	Do you have Syasthosathi card?
V	Do you save money?
VI	If yes, where you save?
VII	Do you have any other source of earning?
VIII	How frequent do you like to deposit amount?
IX	Are you member of any union?

Table 1: Questionnaire containing question in three sections prepared for study of three large local fish markets (New Market, Netaji Market, and Taw Bazar) in Bongaon Municipality. It is notable that the questions are framed in such a way that the answers would be recorded in a 'YES' or 'NO' format.

Results And Analysis:

The data collected from three busiest markets (New Market, Netaji Market, and Taw Bazar) of Bongaon Municipality shows its demographic characteristics of participant fish traders, including their age, gender, education, and experience **(Table 2)**.

Table 2: Demographic Characteristics of Fish Traders

Characteristics	Categories	New Market (%)	Netaji Market (%)	Taw Bazar (%)
Age	18-30	4.17	0	15.38
	31-45	12.5	41.67	23.08
	46-60	7.83	33.33	50
	>60	12.5	25	11.54
Gender	Male	100	100	100
Education	Illiterate	0	16.67	3.85
	Up to Primary	33.33	8.33	15.38
	M.P.	50	41.67	38.46
	H.S.	8.33	0	11.54
	Graduate	8.33	33.33	30.77
Experience	1-5 Yr	0	0	3.85
	6-10 Yr	8.33	0	23.08
	11-15 Yr	25	25	7.69
	16-20 Yr	33.33	25	46.15
	>20 Yr	33.33	50	19.23

In New Market, the majority of respondents are in the 46-60 age group, accounting for 70.83%. However, in Netaji Market and Taw Bazar, the major age groups are 31-45 and 46-60, representing 41.67% and 50% respectively. There are no female fish traders, all fish traders are male. In all three cases the majority of respondents completed Madhyamik standard of education (New Market-50%, Netaji Market – 41.67%, and Taw Bazar – 38.46%), even among them some possess graduate degree, their percentage value is not negligible, in the case of New Market their percentage is 8.33, but in Netaji Market and Taw Bazar their percentage value is higher, 33.33 and 30.70, respectively. Regarding illiteracy New Market shows the best scenario with no illiterate fish trader but little deviation has been seen in Taw Bazar having 3.85% and comparatively worst condition is found in Taw Bazar with 16.67%. On the basis of experience, it can be seen that most of the fishmongers have 16-20 and more than 20 years of experience in all three markets.

Regarding 'Post-Harvest Management and Preservation' (first Section of the Questionnaire) containing 17 general questions, the answers given by fish traders of all three fish markets are quite noteworthy. They are confident enough to their opinion such as the nutritional value and quality of fish, causes of spoilage and their impacts, post-harvest care of fish maintaining proper hygiene with and its importance in reducing economic losses, the usefulness of incorporating courses on post-harvest preservation in curriculum of educational institute, and the impact of scientific fish management and trade on the economy of the country. Their clear understanding of these topics is commendable.

Although most of the fishmongers have not been able to scientifically explain the molecular characteristics of the portion of the fish that is consumed as food and the structural changes that occur during decomposition due to their lack of knowledge, they all have a general idea that fish is mainly composed of protein and fat and most of our edible proteins needed for nutrition comes from fish (**Figure 1**). But many of them have little idea that the main cause of this spoilage is protein and frequent watering will speed up the spoilage, while the technique of keeping the fish fresh by sprinkling water repeatedly is a traditional practice of fishmongers. When they are asked whether post-harvest fish care is equally significant as the amount of total fish captured, the majority of the respondents give their assertive consent but majority of those respondents who are agreed upon aforesaid point, are totally unaware about the huge economic loss due to carelessness, and unscientific handling of fish during post-harvest preservation. When asked about post-harvest economic losses, livelihood opportunities, and the benefits of fisheries as well as the importance of fisheries in the growth of the country's GDP, it was evident that they had little knowledge about these issues. The respondents from the three markets have varied responses to the questions about the adequacy of physical infrastructure of the fish markets, satisfaction with the cleanliness of the interior environment of the fish market, and the local administration efforts to improve the overall markets infrastructure (**Figure 2**).

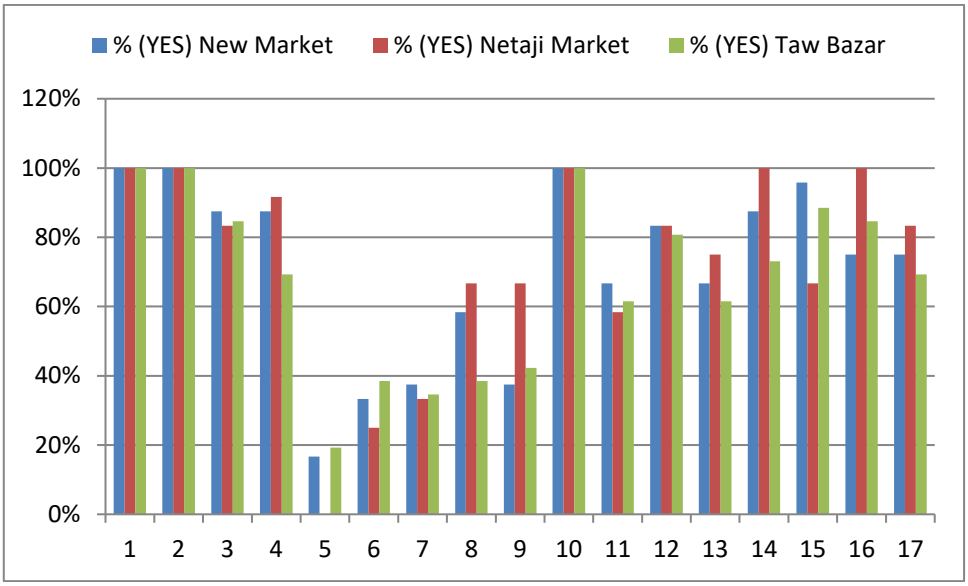

Figure 1: The graphical presentation of data for the first section of questionnaire having 17 questions (excluding 9a, 9b, and 9c) regarding 'post-harvest management and preservation', obtained from New Market, Netaji Market, and Taw Bazar. The percentage value of question wise answers (only 'YES') is plotted on Y axis.

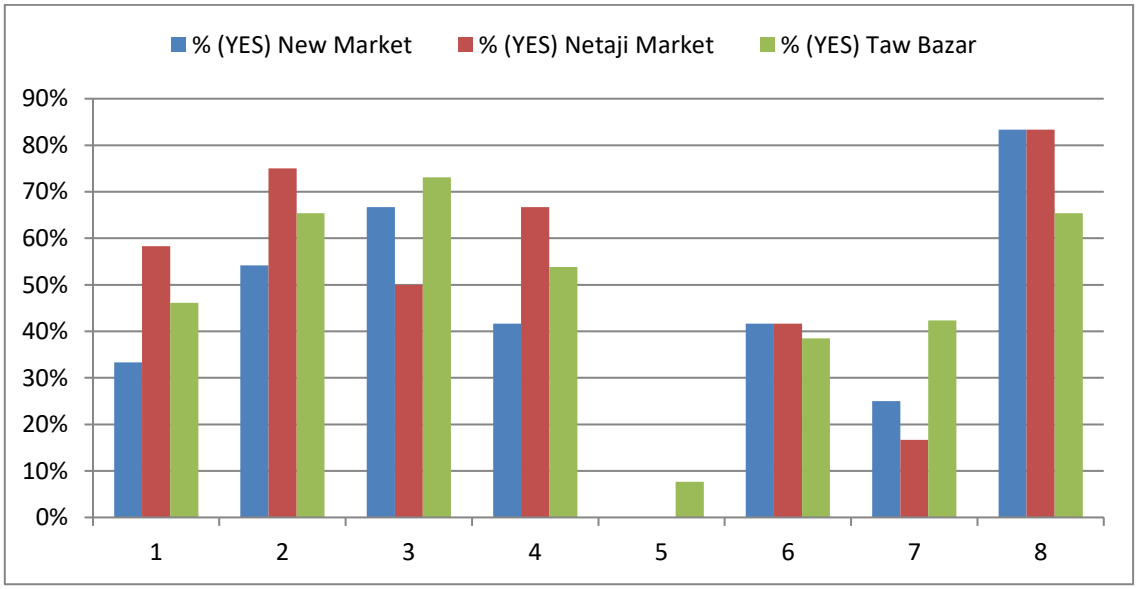

Figure 2: The graphical presentation of data for the second section of questionnaire having 8 questions regarding 'Infrastructure, Communication System, Contribution in Indian Economy, Health and hygiene', obtained from New Market, Netaji Market, and Taw Bazar. The percentage value of answers (only 'YES') for each question is plotted on the Y-axis.

In New Market, majority of fish traders (58.33%) have the optimum knowledge about various fish preservation techniques in addition to chilling and icing techniques. But a smaller number of them (37.5%) has the knowledge about the formalin preservation **(Figure 3)**. A large percentage of those who have heard and gather knowledge about formalin preservation techniques also know about its harmful effect after consumption (88.89%) and even it is known to a large percentage of traders (66.67%) who are familiar with formalin preservation that formalin is used mainly as preservatives of dead bodies (**Figure 9**). Majority of the fish traders in New Market are not satisfied with the infrastructure (33.33%) and initiatives of the local administration (41.67%), but a little over half a percentage of the people (54.16%) feel that the market environment is healthy for them. Most of the fish traders support that the fish market should be kept separate from the vegetable market (66.67%) and the fishery sector should be given the status of a separate industry (83.33). None of the traders are aware about the employability of the fish sectors, less than 50% of them aware about the contribution of

fish sector in country`s GDP (41.67%) and the fact that fishes are also used for making manure, ornaments, home décor, biscuits etc. are known to a meager portion of fish traders (25%) **(Figure 4)**.

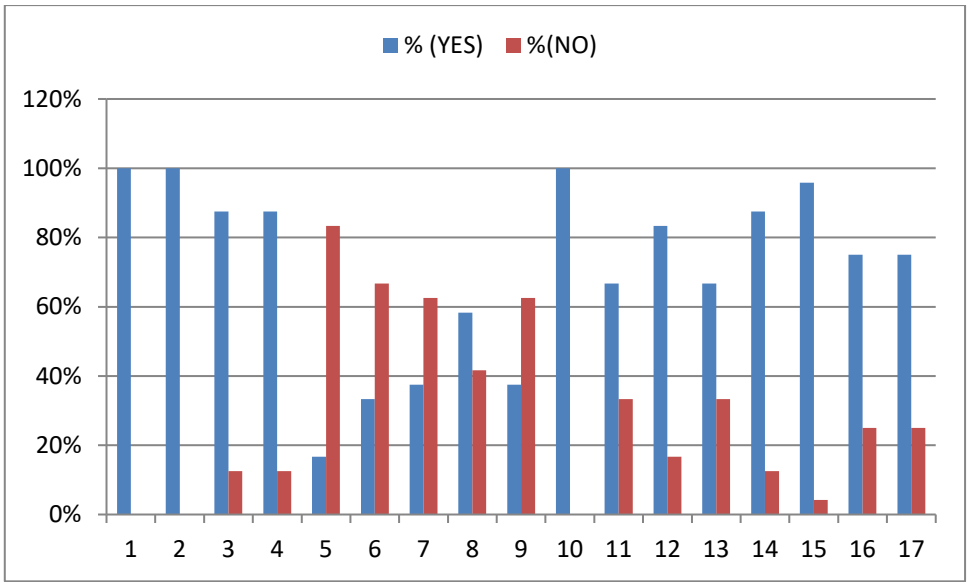

Figure 3: The graphical presentation of data for the first section of questionnaire having 17 questions regarding 'post-harvest management and preservation', obtained from New Market. The percentage value of question wise answers is plotted on Y axis.

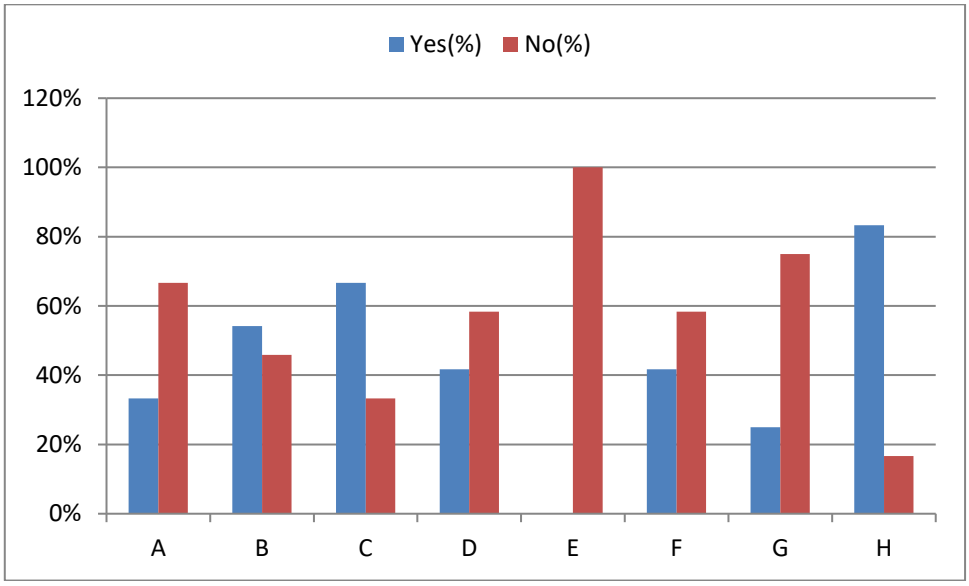

Figure 4: The graphical presentation of data for the second section of questionnaire having 8 questions regarding 'Infrastructure, Communication System, Contribution in Indian Economy, Health and hygiene', obtained from New Market. The percentage value of answers for each question is plotted on the Y-axis.

After analyzing the responses of the Netaji market fishmongers to the first section of the questionnaire, it was found that most of the answers were similar to those from New Market, with only minor differences in the percentage values (**Figure 5**). The exceptions were apparent in the variation in responses to questions about formalin preservation. More than 50 percent of fish traders in this market are aware of formalin preservation of fish and the responses for questions 9a, 9b, and 9c closely match those of the New Market traders (**Figure 9**). But the responses to the second part of questionnaires regarding market`s infrastructure, healthy environment and administrative co-operation suggest a different view than New Market traders. Fish traders of Netaji Market are happy with their market infrastructure, internal environment and local administration's cooperation and willingness to improve it in the future, so the percentage values of 'YES' answers to questions

A, B and D are 58.33, 75, 66.67 respectively. Regarding the co-existence of fish market and vegetable market, there is an equal 50% division between 'YES' and 'NO' (**Figure 6**).

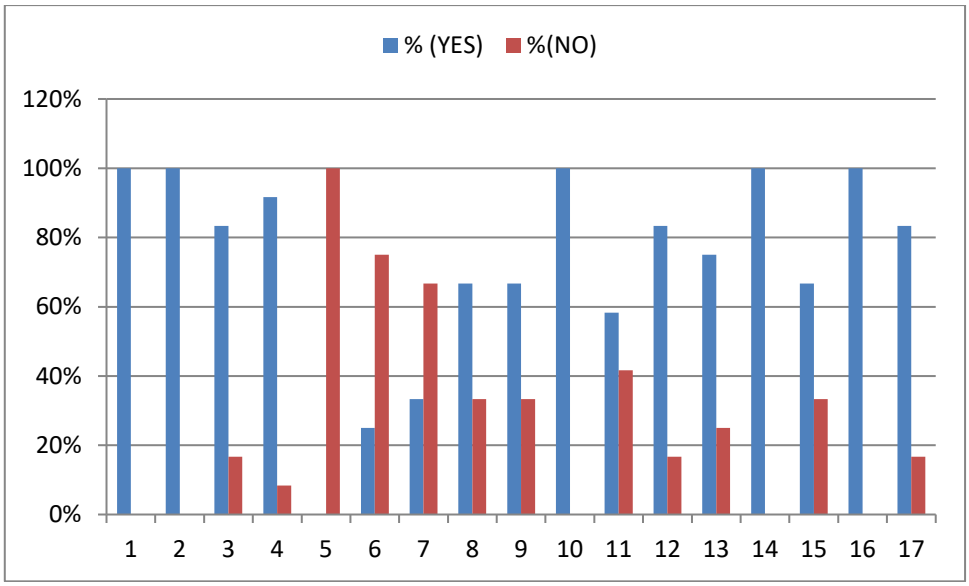

Figure 5: The graphical presentation of data for the first section of questionnaire having 17 questions regarding 'post-harvest management and preservation', obtained from Netaji Market. The percentage value of question wise answers is plotted on Y axis.

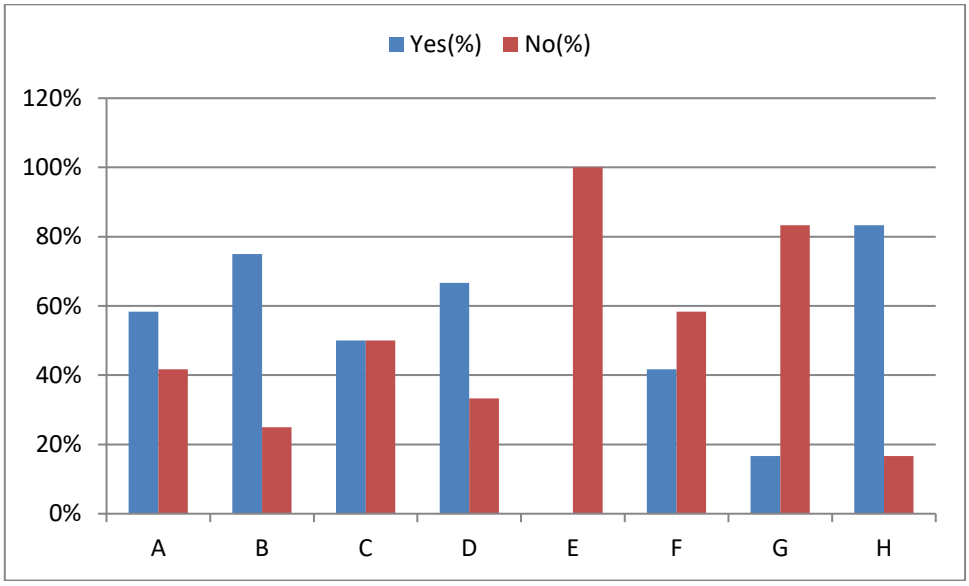

Figure 6: The graphical presentation of data for the second section of questionnaire having 8 questions regarding 'Infrastructure, Communication System, Contribution in Indian Economy, Health and hygiene', obtained from Netaji Market. The percentage value of answers for each question is plotted on the Y-axis.

The answers of fish traders of Taw Bazar follow more or less same patterns as previous two markets with slight fluctuation in percentage though for few parameters their opinion differs (**Figure 7**). Unlike fish traders of New Market and Netaji Market, they are not aware about the other processes of fish preservation besides chilling and icing, only 38.46% of them know it. Regarding formalin preservation their responses are similar to those of New Market, with the exception prevailing in the case of identifying formalin preserved fish where a higher number of respondents (54.55%) are noticed (**Figure 9**). They are not happy with the market`s infrastructure and 'YES' respondents on this issue are less than 50% (46.15%) but majority of fish traders express their satisfaction on the hygiene of the inner environment (65.38) and the initiatives taken by local governing authority (53.85%) (**Figure 8**).

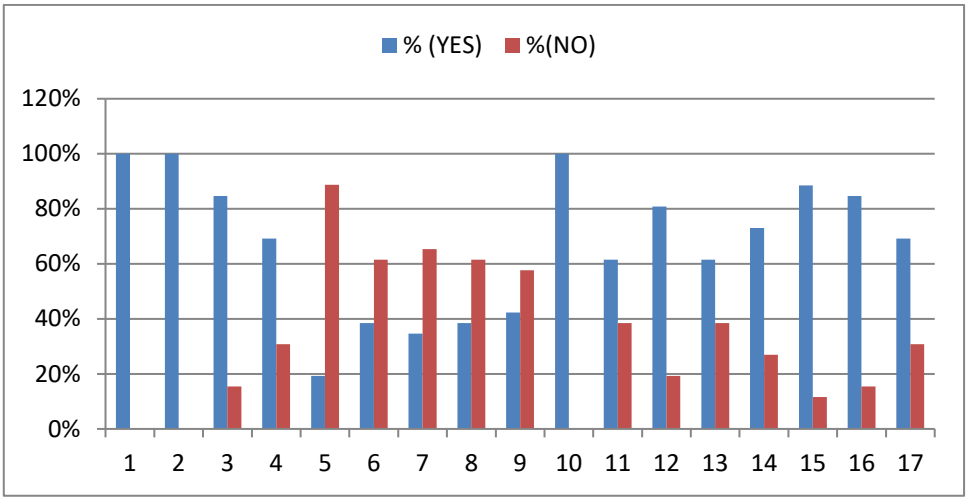

Figure 7: The graphical presentation of data for the first section of questionnaire having 17 questions regarding 'Post-harvest management and preservation', obtained from Taw Bazar. The percentage value of question wise answers is plotted on Y axis.

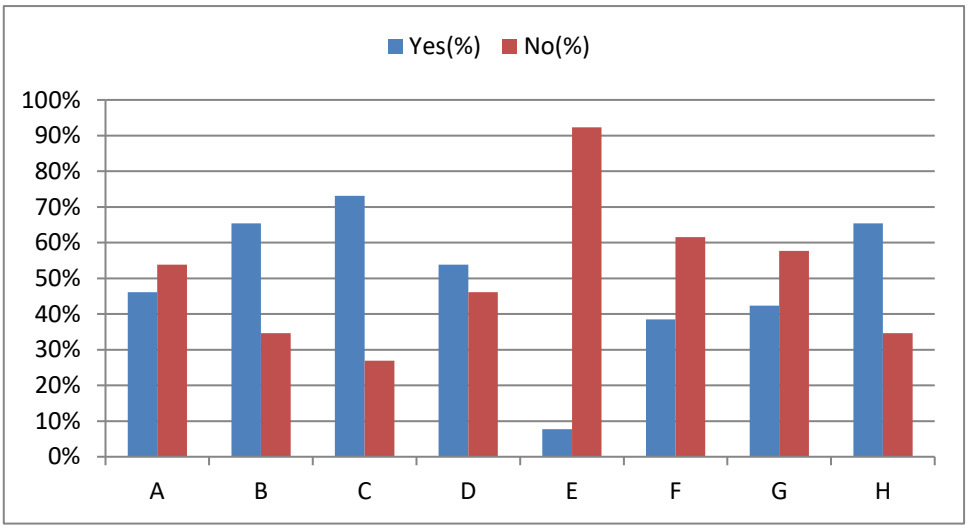

Figure 8: The graphical presentation of data for the second section of questionnaire having 8 questions regarding 'Infrastructure, Communication System, Contribution in Indian Economy, Health and hygiene', obtained from Taw Bazar. The percentage value of answers for each question is plotted on the Y-axis.

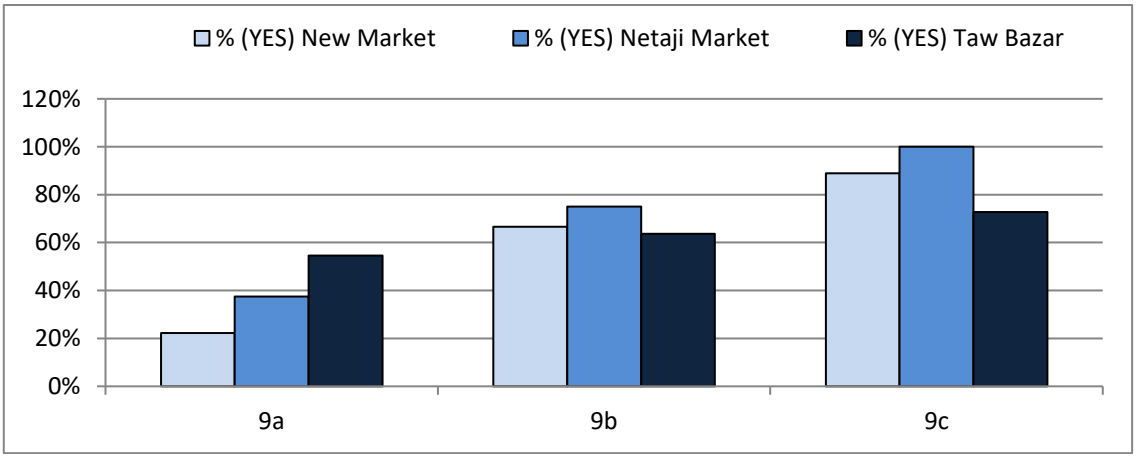

Figure 9: A graph representing the data from questions 9a, 9b, and 9c about knowledge of formalin preservation. This data is collected from individuals knowledgeable about the use of formalin for fish preservation (only 'YES' respondents of question 9) in New Market, Netaji Market, and Taw Bazar. The Y-axis represents the percentage of 'Yes' responses for each question.

Table 3: Third section questions of the questionnaire and the percentage value of the responses of the fish traders on three fish markets (New Market, Netaji Market, and Taw Bazar) of Bongaon Municipal are.

Question No.	Categories	New Market (%)	Netaji Market (%)	Taw Bazar (%)
I	Holidays	16.67	16.67	3.85
	Holidays/Festive seasons	45.83	33.33	53.85
	Weekdays/Festive seasons	8.33	8.33	11.54
	Festive seasons	29.17	41.67	30.77
II	Summer	8.33	0	0
	Winter	0	0	0
	Rainy season	91.67	100	100
III	YES	37.5	33.33	53.85
	NO	62.5	66.67	46.15
IV	YES	70.83	41.67	73.08
	NO	29.17	58.33	26.92
V	YES	100	100	100
	NO	0	0	0
VI	Cheat Fund	0	0	0
	Bank	33.33	33.33	23.08
	Bank/PO	29.17	33.33	23.08
	Bank/PO/Insurance	16.67	33.33	26.92
	Bank/ Insurance	20.83	0	26.92
	PO	0	0	0
VII	Savings	37.5	50	57.69
	Savings/Assets	29.17	25	11.54
	Savings /Assets/Trades	20.83	16.67	19.23
	Savings/Trades	12.5	8.33	11.54
VIII	Monthly	75	50	61.54
	Weekly/Monthly	16.67	16.67	19.23
	Monthly Quaterly	8.33	33.33	15.38
	Quarterly	0	0	3.85
IX	YES	29.17	33.33	34.62
	NO	70.83	6667	65.38

In the analysis of the data from the third section of the questionnaire, which focuses on the economic and social security of fish traders, a diverse range of results has been observed (**Table 3**). The comparative data shows that the maximum and minimum income in a day at all three fish markets is quite similar. However, Taw Bazar shows a slightly better scenario in both maximum and minimum daily earnings **(Figure 10)**. The majority of fish traders from three markets have opined that holidays and festive seasons are their main periods for generating profit. Among the three distinct seasons - summer, winter, and rainy season - it is the rainy season that brings the most profit, nearly all respondents agreeing with this. Life insurance coverage is lower among fish traders at New Market and Netaji Market (37.5% and 33.33% respectively), although there has been a slight improvement among fish traders at Taw Bazar, where the coverage stands at 53.85%. Only 41.67% of fish traders at Netaji Market have the "Syasthosathi Card", which is the lowest percentage compared to fish traders at the other two markets, where the coverage is 70.83% at New Market and 73.08% at Taw Bazaar. All respondents are committed to saving money on monthly basis, with the bank being the most popular choice for deposits, although some also consider the Post Office and Insurance for savings. For most fish traders, savings serve as an additional source of income, although some derive income from their assets and other trades. In all three fish markets, the majority of fish traders are not affiliated with any union (**Table 3**).

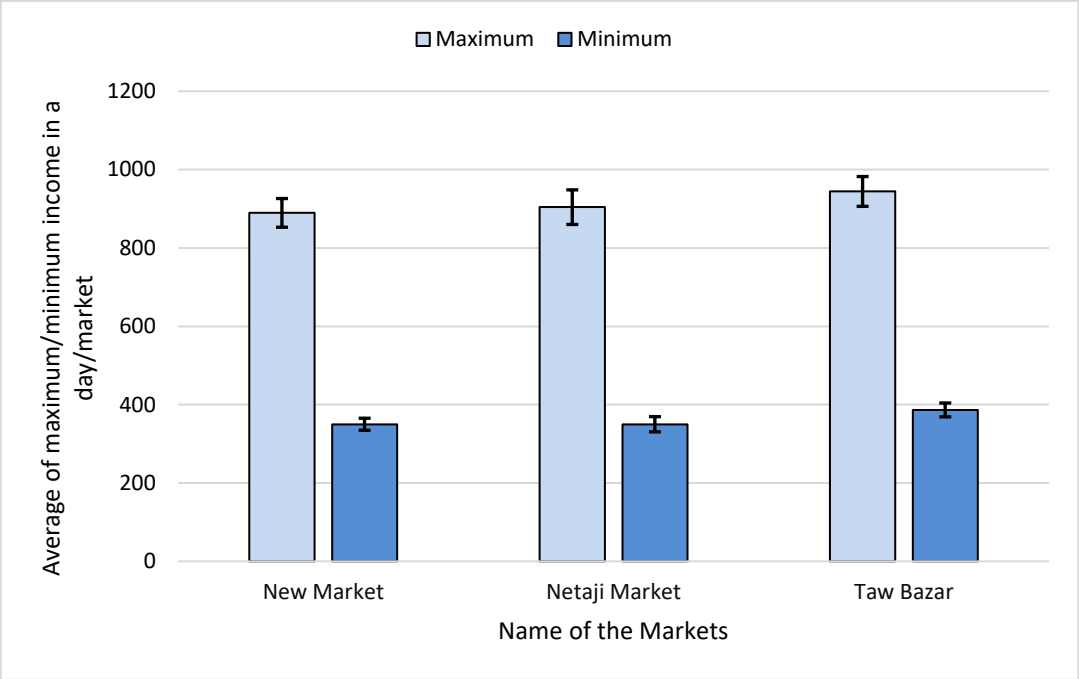

Figure 10: Graphical presentation of data from three fish markets (New Market, Netaji Market, and Taw Bazar) to show average maximum and minimum earning in a day. Values are mean ± S.E.M of three markets.

Discussion:

Post-harvest fish loss occurs when fish is discarded or sold at low price due to quality deterioration. This leads to a direct loss of income for fish operators and a reduced availability of fish for consumers (Yvette, 2011; Mgawe et al., 2011). India is struggling with yearly post-harvest losses amounting to Rs 61,000 crore in both marine and inland fisheries. Especially inland fisheries have reported higher annual post-harvest losses of Rs. 46000 crores compare to marine fisheries, which reported losses of Rs. 15000 crores. These losses are mainly caused by inadequate handling practice, delayed packing and transportation, and insufficient cold storage facilities (Deshmukh et al., 2014; Ara et al., 2019; Mohan, 2020).

In highly populated Low Income Food Deficit Countries like India, where the fishery sector is considered as an important sector of people's livelihood, there is a need to pay more attention to post-harvest protection of fish. In our survey most of the fish vendors in the three markets are aware of this, with almost all stating that post-harvest fish preservation is as important as the total harvest. Although there is a preconceived notion that those involved in the fish trade are generally illiterate or less educated. But our present study found that a large proportion of fish sellers are educated at secondary level and above which has helped them to be aware of various issues. Not only that, most of them have more than 15 years of experience (**Table 2**). They all know that the main constituents of fish are proteins and fats and without proper preservation fish rots (Michael, 1988; Grainger et al., 1997). Although most of them know that the reason for this spoilage is mainly the degradation of proteins and fats, they may not know that sprinkling water on the fish to keep it fresh while selling actually helps the fish to rot more quickly, which has now been proven (Michael, 1988; Grainger et al., 1997).

Less than half a percent of the people (48.83%) in three fish markets are aware of the process of the process of fish preservation using formalin. Among those who are aware, only 38.10% of traders can identify formalin-preserved fish. However, the majority of them (87.20%) know that the formalin-preserved fish is very harmful to health, and 68.44% of traders who are familiar with formalin-preserved methods know that formalin is a chemical used to preserve the carcasses and corps (**Figure 9**). Since the people of this region prefer to eat fresh and live fish, there is less demand for long-preserved fish, so illegal method like formalin-preservation is not popular among traders here.

The time lag between catching fish from various sources and selling to buyers is crucial because fish undergo chemical and biological changes quickly after capture as a result of enzymatic catalysis of fish macromolecules. To save money, local fish farmers and stakeholders avoid using ice to preserve fish captured in various bodies of water. On the other hand, local markets have a minimal demand for ice-preserved fish. In this situation, enhancing the communication system is critical. Due to poor transportation and a lack of market awareness,

fish owners are forced to hold their catch for extended periods of time, resulting in deterioration in fish quality. The majority of fishmongers at these three fish markets are pleased with the current communication method.
Fish dealers buy big amounts of fish and try to sell them in the morning. However, consumers prefer to buy fish later in the day when prices are lower. During this lengthy period, dealers use traditional knowledge to keep fish fresh by sprinkling water on them. This extra water helps to break down protein and fat by activating hydrolytic enzymes such as protease and lipase. On the other hand, this overly humid state, along with the high ambient temperature, offers an excellent habitat within the fish market for fish rotting. This ideal environment also attracts bacterial species such as *Pseudomonas, Alcaligenes, Vibrio, Serratia, and Micrococcus* (Gramme and Huss, 2000). Fish spoil due to microbial development and metabolism, resulting in the formation of biogenic amines such as putrescine, histamine, and cadaverine, as well as organic acids, sulphides, alcohols, aldehydes, and ketones with unpleasant and objectionable odours (Dalgaard et al., 2006; Emborg et al., 2005). This eventually leads to a deterioration in fish quality, which results in losses for vendors, especially in small-scale fish markets.

Although the majority of fish traders (82.48%) agree that employing adequate fish handling procedures and maintaining hygienic practices can prevent fish spoilage, more than half believe that fish market infrastructure does not match the essential standards. However, they are pleased with the cleanliness and environment of the fish market and applaud the efforts of local governments to construct excellent fish markets. Fish vendors (66.67% in New Market, 50% in Netaji Market, and 73.08% in Taw Bazar) are particularly concerned of keeping the fish market distinct from the vegetable market to ensure good hygiene (Figure 2). Poor infrastructure has been linked to poor fish handling practices, such as the use of unclean fish boxes, baskets, vessels, and equipment, as well as washing fish with dirty water and laying fish on unclean surfaces, all of which contribute to faster fish deterioration. Majority of Fish traders (83.33% in New Market, 83.33% in Netaji Market and 65.38% in Taw Bazar) are more concerned about the fact that fishery sector should be treated as industry in spite of their little knowledge on its contribution in country`s GDP and number of employees engaged in fisheries sector (**Figure 2**).
Human resources in our country involved in post-harvest processing are underequipped and lack current scientific advanced knowledge and experience in this field. The majority of people in this country believe that fishing is not a preferred or popular source of income. National and state governments, non-governmental organisations, local governing bodies, and regional colleges and universities should all take initiatives to reduce post-harvest losses and give all fisheries sector workers with the appropriate training and skills. According to our study, 86.54% of fish dealers think that regular short-term courses on post-harvest fish preservation should be held with the assistance of colleges, universities, and other organisations, and 75.66% think that this instruction ought to be covered in the curriculum of public schools (Figure 1).
Our survey found that fishmongers are wary about preserving money for the future. They tend to save money in a variety of organisations, including banks, post offices, and insurance firms, with no business owner deciding to rely entirely on the post office. However, a large proportion of fishmongers in all three markets lack life insurance, raising concerns about their families' financial security. Furthermore, while many fishmongers have health cards, not everyone has, which poses a risk to their personal and family health (Table 3).

Conclusion:

The current study seeks to communicate a crucial message to fish buyers and traders. It emphasises the importance of not just collecting a huge number of fish, but also applying appropriate post-harvest preservation methods. The study also intends to encourage fishmongers to participate in short-term training courses to receive proper education for scientific post-harvest fish preservation. The study's findings stress the importance of focusing on the market's architecture, internal environment, and personal cleanliness in order to provide buyers with appetising and healthy fish. The information acquired from this study will help the government, local governments, and non-governmental organisations (NGOs) analyse the situation and develop future policies. It emphasises the importance of everyone, from the general public to the government, taking responsibility to reduce the significant post-harvest losses in India's fishing sector that occur every year, resulting in financial loss for individuals in this business, as well as to improve the fishery sector overall.

Acknowledgement

The authors are thankful to the Principal of Dinabandhu Mahavidyalaya, Bongaon, for providing necessary facilities for conducting research. We also thank the students of Semester VI, Zoology Honours, - Debjit Adhikary, Soumyarup Biswas, Anandee Sarma, Suryashankha Ghosh, Arpita Bala Gain, Akash Biswas, Bikash Das, Sanjana Kanjilal, for assisting in data collection and analysis.

Reference:

1. Adewolu, M. A., and A. J. Adeoti. 2010. Effect of mixed feeding schedules with varying dietary crude protein levels on the growth and feed utilization of *Clarias gariepinus* (Burchell, 1822) fingerlings. Journal of Fisheries and Aquatic Science 5:304-310.
2. AMEC. 2003. Management of wastes from Atlantic seafood processing operations. AMEC Earth and Environmental Limited, Dartmouth, Nova Scotia, Canada. http://aczisc.dal.ca/nparpt.pdf
3. Aminah, A. S., H. Zailina, and A. B. Fatimah. 2013. Health risk assessment of adults consuming commercial fish contaminated with formaldehyde – Food Pub. Health 3: 52-58,
4. Amos, B. 2007. Analysis of quality deterioration at critical steps/points in fish handling in Uganda and Iceland and suggestions for improvement. United Nations University, Uganda. http://www.unuftp.is/static/fellows/document/amos 06prf.pdf
5. Annual Report, 2022-2023, Govt. of India, Dept. of Fisheries
6. Ara, Y., Zannat, M., Ferdoushi, Z., Gupta, N. and Roy, K.P., 2019. Fish Market and Socio-Economic Issues of Fish Traders: Present Status and Constrains. Journal of Science and Technology, 17, pp.1-9.
7. Baird-Parker, T. C. 2000. The Production of Microbiologically Safe and Stable Foods. In: The Microbiological Safety and Quality of Food, Lund, B.M. and T.C. Baird-Parker (Eds.). Aspen Publishers Inc., Gaithersburg, MD., USA., ISBN: 0834213230, pp: 3-18
8. Berkel, B. M., B.V. Boogaard, and C. Heijnen. 2004. Preservation of Fish and Meat. Agromisa Foundation, Wageningen, The Netherlands, ISBN: 90-72746-01-9 pp: 78-80
9. Bongaon Town Population Census. Link: https://www.census2011.co.in/data/town/801691-bongaon-west-bengal.html
10. Cold Chain and Post Harvested Infrastructure Development - 22, Action Plan, Towards Blue Revolution, DEPARTMENT OF ANIMAL HUSBANDRY, DAIRYING & FISHERIES MINISTRY OF AGRICULTURE & FARMERS WELFARE GOVERNMENT OF INDIA July 2017
11. Dalgaard, P., H. L. Madsen, N. Samieian and J. Emborg. 2006. Biogenic amine formation and microbial spoilage in chilled garfish (Belone belone) effect of modified atmosphere packaging and previous frozen storage. J. Applied Microbiol 101: 80-95. DOI: 10.1111/j.1365-2672.2006.02905.x
12. Deshmukh, D.R. and Jawale, C.S., 2014. Study of fish markets in Paithan, Dist. Aurangabad, Maharashtra. *Trends in Fisheries Research, 3*(3), pp.5-6.
13. Emborg, J., B. G. Laursen, and P. Dalgaard. 2005. Significant histamine formation in tuna (Thunnus albacares) at 2°C: Effect of vacuum-and modifiedatmosphere-packaging on psychrotolerant bacteria. Int. J. Food Microbiol 101: 263-279. DOI: 10.1016/j.ijfoodmicro.2004.12.001
14. FAO., 2005. Post-harvest changes in fish. In: FAO Fisheries and Aquaculture Department, Food and Agriculture Organization, Rome, Italy. http://www.fao.org/fishery/topic/12320/en
15. Goon S., M. S. Bipasha, and M. S. Islam. 2014. Fish marketing status with formalin treatment in Bangladesh: An overview – Int. J. Pub. Health Sci 3: 95-100
16. Grainger, R., 1997. Recent FAO activities related to by-catch and discard issues. FISHERY AND AQUACULTURE STATISTICS, p.8.
17. Gram, L., and H.H. Huss. 2000. Fresh and Processed Fish and Shellfish. In: The Microbiological Safety and Quality of Foods, Lund, B.M., A.C. BairdParker and G.W. Gould (Eds.). Chapman and Hall, London, ISBN: 10: 0834213230, pp: 472-506
18. Hossain, M.S., M. A. Rahman, K. T. Sharkar, and H. M. Shahjalal. 2008. Formaldehyde Content in Rui fish (Labeo rohita) in Bangladesh and effect of formaldehyde on lipid peroxidation in rat tissues and intestinal tissues – J. Med. Sci 8(4): 405-409
19. IARC., 2004 – Monographs on the Evaluation of Carcinogenic Risk to Humans – Yearbook 88, International Agency for Research on Cancer, Lyon, France
20. Luten, J., W. Bouque, L. Seuren, M. Burggraaf, G. Riekwel-Body, P. Durand, M. Etienne, J. Gouyo, A. Landrein, A. Ritchier, M. Leclerq, and R. Guinet. 1992. Biogenic amines in fishery products:

Standardization methods within EC. In Quality assurance in the fish industry. pp 427–439. Huss, H., Ed. Elsevier Science Publishers
21. Mgawe, Y.I. and Diei-Ouadi, Y., 2011. Post-harvest fish losses in small-scale fisheries: operator's manual for reducing post-harvest losses to increase income. Food and Agriculture Organization of the United Nations.
22. Michael, T. M. 1988. Postharvest fishery losses. Proceedings of an International Workshop, The University of Rhode Island, Kingston, ICMRD, pp:12-16
23. Mitra,, P. 2018. Formalin in fish may be fatal in long run: Doctors. TNN/ July 18, 2018, 06:57 IST
24. Mohan, V. 2020. India reports annual post-harvest losses of Rs 61,000 crore in fisheries, finds parliamentary panel. TNN | Mar 15, 2020, 10:43 IST
25. National fisheries Development Board, https://nfdb.gov.in/welcome/Fish_and_Fisheries_of_India
26. Shalaby, A. R. 1996. Significance of biogenic amines to food safety and human health. Food Res. Int. 29:675–690
27. Silla-Santos, M. H. 1996. Biogenic amines: Their importance in foods. Int. J. Food Microbiol. 29:213–231,
28. ten Brink, B., C. Damink, H. M. L. J. Joosten, and J. H. J. Huis in't Veld. 1990. Occurrence and formation of biologically amines in food. Int. J. Food Microbiol 11:73–84
29. Yvette, Yahya I. 2011. Post-harvest fish loss assessment in small-scale fisheries, (FAO) Fisheries and Aquaculture Technical Paper. A guide for the extension officer, Rome, Italy. P. 559