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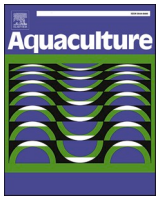

Consumer preference for fish safety inspection in Bangladesh

Mohammed Ziaul Hoque [a,b,*], Øystein Myrland [a]

[a] School of Business and Economics (HHT), UiT The Arctic University of Norway, Norway
[b] Department of Finance, University of Chittagong, Chittagong, Bangladesh

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ABSTRACT

Consumers are entitled to eat safe food, so authorities should ensure that this right is preserved by enacting regulations and ensuring compliance through enforcement activities. Safety inspection is key to the enforcement system. Therefore, this paper presents an analysis of consumer responses to a regulatory scheme for safe seafood. The regulations consist of national and local authority enforcement and subsequent follow up activities to ensure that all wild and farmed fish in all product formats are safe. We collected primary data from two major cities in Bangladesh, Dhaka and Chittagong. The data were analysed using conditional and generic multinomial logit models to identify different utility ratios. We find that consumers expect safety control information at a low mental cost or effort. They value fish safety inspection highly in their affective reaction, whereas this value is lacking in their cognitive response. The individual parameter estimates show that consumers' preferences for both wild and farmed fish are significantly positive. They are most likely to reject frozen fish and be willing to pay less for it. Wild-caught fish creates utility for consumers without any food safety inspection, but this is not the case for farmed, frozen fish. The lack of authorised food safety inspection significantly decreases utility, suggesting a positive market potential, particularly for farmed fish with local authority safety certification.

1. Introduction

The rapid growth of agro-farming has led to many unjust works requiring significant natural resources, including energy and water. In this context of unsustainable growth, food security is a critical concern for sustainable food consumption (Hoque and Alam, 2018; Roy et al., 2019). The challenge of food security is to guarantee that people have access to the food they require, free from chemical, physical and biological contaminants (Hanning et al., 2012). Without food safety, we cannot have food security (King et al., 2017), and food safety thus needs to be addressed and improved without delay (Lucia et al., 2013). Food security can be ensured by tightening trading hygiene requirements (FAO, 2018) or imposing additional charges and safety requirements on imports (Ababouch, 2006). This might increase food or business costs (Akinbode et al., 2012), some of which will be transferred to consumers in the form of higher prices. Consequently, there is an urgent need to assess consumers' willingness to pay (WTP) to control food safety (Akinbode et al., 2012).

Consumers are concerned about the safety of their food intake. Following various food-safety scandals (Trienekens and Zuurbier, 2008), customer's perceptions of safety can also impact a country's image (Madichie and Yamoah, 2006). Consumers in developed countries are aware of food safety and risk issues. In many developing countries, food safety remains the responsibility of consumers (Tjaart and van Veen, 2005). One of the significant challenges for developing countries is stricter food safety requirements (Henson et al., 2000). For many of these countries, food price, taste, and buying convenience seem to play a more significant role than food safety issues (FAO, 2015). Although developing countries have neglected food safety and the development of food safety systems (Grace, 2015), consumers in these markets are likely to become increasingly aware of such issues as incomes continue to grow and if urbanisation continues at the current rate (Ortega and Tschirley, 2017). Seafood from fisheries and aquaculture is crucial for ensuring future food safety and security for households in emerging economies; seafood is an essential source of proteins, vitamins, and micronutrients for many families (Garcia and Rosenberg, 2010).

There has been a steady growth in the production, consumption, and export of farmed fish, in developing countries, particularly in Asia (Claret et al., 2014), and more specifically in China and India, and emerging markets such as Thailand, Indonesia, Vietnam and Bangladesh (Dey, 2000). This growth has mostly been driven by rising incomes and urbanisation in South Asian countries such as Bangladesh (FAO, 2018).

* Corresponding author at: Room 01.307 at School of Business and Economics (HHT), UiT The Arctic University of Norway, Tromsø, Norway
E-mail addresses: mohammed.z.hoque@uit.no (M.Z. Hoque), oystein.myrland@uit.no (Ø. Myrland).

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Bangladesh has become the fourth largest fish producing economy globally (FAO, 2016; OECD, 2020) and is ranked third in aquatic biodiversity (Shamsuzzaman et al., 2017). It has an extensive coast, with a rich delta feeding massive capture and culture fisheries. From 2005 to 2016, the country's per capita fish consumption increased by 49%, reaching 22.85 kg in 2016 (HIES, 2016), higher than the average global consumption of 20.5 kg per capita (FAO, 2020). Regrettably, these high fish production and consumption levels are not accompanied by food safety schemes or rigorous hygiene inspections (Rahman et al., 2012).

People classify foods to construct order in a complex food environment and use these classifications to make everyday food choices (Furst et al., 2000). Since 93% of Bangladeshi households buy and consume fish frequently (Hoque, 2020), classifying fish into wild, inland farmed, and coastal farmed is likely crucial to consumers' fish choice. However, Bangladesh's highly fragmented fish supply chain comprises thousands of small farmers and many traders, intermediaries, and retailers, most of whom operate with little or no supervision. Together this poses a significant challenge to implementing food safety regulations. As a result, many fish safety problems may be found at the farm, preserving and storage level. Many farmers have practised traditional fish farming using toxic pesticides (Rahman et al., 2012).

Furthermore, producers and fish vendors unethically use formaldehyde to preserve the fish and seafood from microbial spoilage, as happens in various wet markets (Rahman et al., 2012). When food is not safe, human development may not occur; therefore, the agenda of emerging economies concerning peoples' access to safe and sufficient food all year round is essential for sustainable development (UN, 2015). Therefore, fish food safety inspections as part of food control are critical to ensure overall food safety and security in emerging markets such as Bangladesh (FAO, 2004).

In an attempt to guarantee food safety, up until 2013, the Bangladeshi food authority had enacted 15 different types of rules and regulations in the form of a penal code, ordinance, and acts (Ali, 2013). However, these rules and regulations are not effective in dealing with food safety problems (Islam and Hoque, 2013). To overcome such problems, the Bangladeshi government has recently adopted the USAID-funded Global Food Security Strategy (GFSS) plan to feed the future involved in food safety and security. In addition, the Management of Aquatic Ecosystems through Community Husbandry (MACH[1]) programme was initiated to achieve safe and sustainable local fisheries management. Government authorities have also enacted mobile courts to frequently intervene to implement the food safety scheme (Hoque, 2020). Although the Bangladeshi government has been attempting to reform laws, establish effective monitoring systems, and strengthen food safety regulations, the primary weak links in the implementation remain (Chowdhury, 2011; Ali, 2013). Therefore, the rapid growth of Bangladesh's fisheries and aquaculture has occurred with less recognition or global acceptance (Hoque, 2020). An effective national food control system is required to protect domestic consumers' safety (FAO and WHO, 2003), and almost all food safety initiatives, government or private, should be nationally centralised. However, these national/central authorities could be delegated to the local level (Reilly et al., 2009), as local authorities are more suitable for food control and can identify the areas of highest risk for consumers and make effective use of resources (Mari et al., 2013; FSA, 2019). Although publicised as a strict approach to remedying food safety concerns, it is unclear whether these latest efforts and fish safety inspections by national and local governments will make fish food safer and improve the country's image.

Consumer demand for food safety is likely to be an essential driver of public policies and industry-led efforts to reduce information asymmetry related to food attributes and improved food safety (Ragasa et al., 2019). Although food safety is receiving increased attention from economists, researchers and policymakers, the literature on the demand for food safety inspections in food control in developing countries is scarce (Birol et al., 2009; Ortega and Tschirley, 2017). Little attention is focused on issues affecting fish quality and the inspection systems of fishery product exports or on consumers' concerns over food safety inspections and their preferences for authority over food control and fish products in Bangladesh. Furthermore, fish consumption behaviour in Bangladesh has not been assessed rigorously (Chowdhury, 2019). Since little is known about this field, its various issues and the clear knowledge gap motivated us to conduct this study. The study's main objective is to support efforts to attain a potential market for fisheries and aquaculture products and formulate an effective policy for food control by predicting consumer preferences and making useful estimates of demand for whole fish.

Therefore, the targeted respondents in this study are households in the two major cities of Dhaka and Chittagong, employing a between-subject design. Respondents were interviewed in an experimental procedure; specifically, we used a choice experiment approach to collect the data and examine preference heterogeneity using descriptive analysis, a conditional logit, and a generic multinomial logit (MNL) model. The study will help predict the heterogeneity in overall fish preferences and in organising a rational market structure in emerging markets that could help identify potential policy implications for fisheries and aquaculture management and provide insights for further research. The study will assist policymakers in drafting and implementing more effective food safety regulations, restoring consumer confidence and re-establishing Bangladesh as a leading exporter of food-safe fish products worldwide.

The structure of the study is as follows. Section 2 contains the literature review, and we then present the theoretical framework. Section 4 details the data collection and methods, and the econometric model is set out in Section 5. The model data are then discussed, and subsequently, the research results are addressed, followed by the concluding remarks and suggestions for further research directions.

2. Literature review

Food safety issues arise from the critical problem of asymmetric information between consumers and producers concerning product-specific attributes (Ortega et al., 2011). Such issues can arise from information asymmetry pertaining to food safety requirements and the deceptive claims of marketers. For instance, unsubstantiated 'green' claims cause reputational harm and make consumers suspicious of the behaviour of suppliers (Peattie, 2001). Moreover, due to the absence of authoritative attributes, consumers cannot determine a product's relevant qualities (e.g. sustainable fish production) even after consuming it; balanced information is, therefore, essential (Monier-Dilhan and Bergès, 2016).

This information problem is even more severe in developing and emerging markets due to their large populations and the lack of reliable safety information. In developing markets, food safety information is often neglected (Grace, 2015) but this information is almost entirely lacking in emerging markets (Carlucci et al., 2015). Negligence and a lack of food safety information lead to a reduction in consumer trust in food safety (Lin et al., 2020) and an inaccurate perception or little awareness of the level of risk. Despite the low awareness of food safety risks, consumers demand food products of high and consistent quality at competitive prices (Trienekens and Zuurbier, 2008; Lin et al., 2020). In response to the proliferation of food values, many public and private standards on food safety and quality have been developed (Trienekens and Zuurbier, 2008), with credible third-party certification being an essential factor in consumer's demand for food safety (Birol et al., 2009). The information gap between market players can be bridged, and the increased inefficiencies that arise from information asymmetry addressed (Ortega et al., 2011) through quality certification (e.g. safety

[1] In Bengali, fish is called mach. In this case, MACH is an USAID project aimed at supporting the effective management of floodplain resources (e.g., fisheries and aquaculture products) to ensure the sustainable supply of food to the poor of Bangladesh.

labelling), the traceability of products origins (Ortega et al., 2011), consumer access to food product attributes (Danso et al., 2017), and increased trust in information and its sources (Hoque and Alam, 2018). Hussain et al. (2017) suggest food safety measures fulfil a useful management function and minimise the risks created by asymmetric information.

Currently, the environment is a source of significant risk associated with seafood safety. Contamination of seafood can occur before harvest or at any point from harvest through to final preparation (Amagliani and Brandi, 2012). Accordingly, aquatic food security and credibility are achieved with a sufficient safe, sustainable, shockproof and sound seafood supply (Jennings et al., 2016). In response, governmental and health authorities have become very concerned about the quality and safety of seafood, increasing regulation, and adopting stringent hygiene measures to stop contaminants (Vipham et al., 2018). Seafood consumption has become an essential part of a balanced and healthy diet (Trondsen et al., 2003), as it is significantly related to public health (Baki et al., 2018); health benefits include lower instances of cardiovascular disease (Verbeke and Isabelle, 2005). In addition, fish is an essential source of quality protein and is cheaper than other animal protein sources for which there is an efficient market structure.

In fish markets, internal cues, such as the sensory characteristics of fish, are critical determinants of fish consumption. These cues are also vital to evaluate the freshness of a fish product (Carlucci et al., 2015). However, sensory characteristics are product specific, and it is not easy to establish that these are fundamental for all fish. For this reason, several studies use attitudes toward fish as a proxy for sensory perception. This is because an attitude is a psychological tendency to evaluate objects in degrees of, for example, good–bad or pleasant–unpleasant, and this attitude can thus be positive (liking) or negative (disliking) (Eagly and Chaiken, 1998). However, consumers' attitudes toward fish products are rapidly changing due to demographic and socioeconomic changes. Therefore, conjoint analysis is widely used in psychometrics, economics, and marketing to assess and estimate consumers' preferences and demand for market and seafood products (Anderson and Sofia, 1993; Roheim et al., 2011).

The expansion in the consumption and commercialisation of fish products have, in recent decades, been accompanied by a growing interest in food safety, nutrition, and waste reduction. Therefore, consumers prefer precise information when purchasing fish, including its visual elements, origin, price, format, and freshness (Brécard et al., 2009). Additionally, consumer fish choice is strongly affected by habits that emerge and are reinforced through experience (Scholderer and Trondsen, 2008). Consumers' perception of fish while purchasing also depends on the convenience and availability of products. When preferred fish products are not available, and the possible alternatives appear to be weak substitutes, consumers decide not to buy anything (Carlucci et al., 2015). Despite being a poor substitute for wild-caught fish, aquaculture has gradually grown to meet the excess demand, meaning that more than 220 species of finfish and shellfish are now cultured (Naylor et al., 2000).

In addition to improving local food supply, aquaculture can also improve food security and nutrition through the availability of low-cost fish and increasing employment opportunities and income (FAO, 2013). Countries must be accountable for what seafood consumers consume rather than what they produce to ensure food security and nutritional quality for a growing world population despite stagnant production in capture fisheries and in light of increasing aquaculture production (Guillen et al., 2019). The demand for and consumption of cultured fish depends on not only credible information but food security and safety systems, and communication of the safety performance requirements of farms, their sustainability indicators, exports of farmed fish, consumer knowledge and perceptions of farmed fish, WTP and equitable distribution of fish to the population (Dey, 2000; Trienekens and Zuurbier, 2008; Dey et al., 2011; Johan et al., 2013; Hussain et al., 2017; Hoque and Alam, 2020; Hoque, 2020).

Although there is extensive literature on consumer behaviour in developed economies in relation to fisheries and aquaculture (Carlucci et al., 2015) and on food safety systems (Grace, 2015), there is little for developing and emerging economies. Although the level of fish consumption is low for people in developing economies, they consume a higher share of fish protein in their diet (FAO, 2018). The domestic fish farms and fish markets of developing and emerging countries in Asia are important, with the dominant market being for whole fish traded as fresh, iced and frozen. However, the influence of the production method and price on the consumer perception of such fish has been little studied in developing countries (Carlucci et al., 2015) and South Asian markets, including Bangladesh (Alam and Alfnes, 2020; Hoque, 2020). No study focuses on the impact on consumers' fish preferences of food safety inspections in fish control. This study attends to these gaps and analyses the segmentation of the Bangladeshi retail finfish market.

In the local Bangladeshi markets, the price of wild fish is higher than that of inland-farmed fish, with the price of coastal-farmed fish lower than that of inland-farmed fish. The literature shows that households with a high level of income buy more fresh fish than those with lower levels of income (Nauman et al., 1995). Therefore, it is logical to assume that high-, medium- and low-income consumers are most likely to buy wild, inland-farmed, and coastal-farmed fish, respectively. In addition, in local Bangladeshi markets, consumers with an average level of knowledge regarding farmed fish are most likely to prefer safe fish; this farmed fish is lower in quality than the organic version (Hoque et al., 2021b). Accordingly, it would be reasonable to assume that a consumer with little knowledge would prefer conventionally farmed fish.

The literature also indicates that low-income consumers are most likely to choose conventional or unlabelled farmed fish (Hoque, 2020). Therefore, high, medium, and low-income consumers are likely to prefer whole fish that has been subject to a national-level food safety inspection (NFSI), local-level food safety inspection (LFSI), or with no authorised food safety inspection (NoFSI), respectively. Based on the similarity to our just-stated hypotheses, we also propose the same explanation for the association between the rate of fish consumption (high, medium, or low) and the level of authority of food safety inspections (NFSI, LFSI, or NoFSI). Accordingly, the value consumers give to food safety inspection authorities can be assessed by their frequency or level of fish consumption.

3. Bangladeshi fish markets and food safety inspections

Consumers in emerging middle-class markets, including Bangladesh, focus more on food safety (Xu et al., 2012; Sudhir et al., 2015). A series of globally- and locally-known food safety scandals has increased awareness of Bangladesh's inefficient food safety measures and inspection systems. Most foodstuffs in its economy are less safe than in other places, and this problem persists at every level of the food chain, from preparation to consumption (Ali, 2013). The food security system remains vulnerable because of the limited coverage of safety schemes, vulnerability to natural disasters, and fluctuation in prices (Roksana and Alam, 2014). Additionally, impure, rotten and perishable food waste is turned into toxic foods and stored, sold and served to consumers in an unhygienic atmosphere (Ali, 2013). The same conditions are true, and to a greater extent, for aquaculture and fisheries products (Rahman et al., 2012).

Fisheries and aquaculture products are key dietary components for the population (Raknuzzaman et al., 2016) and are ranked third among Bangladesh's export commodities (IMED (Implementation Monitoring and Evaluation Division), 2013). In the growth of the fisheries and aquaculture sector in Bangladesh, there has been extensive product differentiation between wild, inland-, coastal, and marine-farmed fish, and in some cases, these products have been marketed with rice or vegetables (FAO, 2016; Hernandez et al., 2018). Globally, 15% of the total animal protein in people's diet comes from fish; this figure is 50% in developing countries and 60% in Bangladesh (Van der Pijl, 2012; DoF,

2018). Although fish is an essential source of food and provides nutrition security and income for many people in Bangladesh (Saiful Islam, 2016), the safety standards in the fish supply chain are inadequate (Van der Pijl, 2012) and complex due to its many stakeholders. In the extended value chain, fish is traded in the primary market (involving fish farmers and local collectors), secondary market (involving wholesalers and local suppliers) and retail market (involving sellers and ultimate consumers). In the retail market, fish are traded in both open or wet markets and hyper- or supermarkets. Due to the product's importance, in terms of market volume, and its significant role in the socioeconomic condition of millions of people in Bangladesh, authorities need to pay proper attention to the retail sector to ensure the quality and safety of the fish and fish-products produced and marketed (Paul et al., 2018; Dey and Surathkal, 2020). The Bangladeshi Fish Inspection and Quality Control wing of the fisheries department have been working since 1997 to sustain a fish-product safety system.

Numerous measures might be required to control food adulteration and ensure the marketing system is effective and strategic. The Bangladesh Food Safety Network is a privately formed network of organisations that implements several educative programmes and communication campaigns for food safety advocacy and awareness; the network aims to increase public consciousness of food safety and foster a safe food movement. Recently, the Bangladesh Safe Food Authority began collecting domestic market data regarding food adulteration to manage the food safety programme effectively. To minimise the risks of the existing system of food safety control, the Bangladeshi government has set food standards and risk assessment procedures in consultation with the Codex Alimentarius Commission.

Following this process, twenty food analysis laboratories formed the National Food Safety Laboratory Network to improve the testing of food samples. An Information, Education and Communications action plan has also been adopted to enhance the food hygiene and safety awareness of households, schoolchildren, food vendors, and advocacy groups. Furthermore, a Food Safety Unit has been formed to develop effective policies and to institutionalise and ensure the good governance of the existing food safety control system. Finally, a pathogen-specific surveillance system tracks food-borne illnesses following the food safety guidelines introduced for the farmed finfish supply chain.

Bangladesh has perhaps the highest number of food safety laws, regulations and initiatives in the world to regulate the safe delivery to consumers of food, including fish and fish products. These diverse regulations and inspections show multi-sectoral responsibility for food control (FAO, 2004), which entirely excludes the HACCP and Codex standards (Banglapedia, 2015). Increasing safety standards formulation capacity based on risk will contribute to the institutionalisation and good governance of food control systems and food safety practices in value chains. Increasing these standards will also change household attitudes, resulting in demand in Bangladesh for safe fish (FAO, 2017). However, the existing control frameworks suffer from abysmal implementation (Chowdhury, 2011), stemming from regulatory failures, a lack of information to consumers (Ali, 2013), and a lack of consumer verification. Therefore, this study explores how consumers value food safety and what their preferences are for fish safety inspections to help design an effective food regulation policy.

4. Data collection and measures

One of the most common carp species, Rui (*Labeo rohita*), is a widely produced, popular and extensively consumed fish in Bangladesh. It is both wild-caught and farm-raised, produced in both inland freshwater and brackish water, and contributes to around half of total fish consumption (Khan et al., 2020). Since our main interest is to investigate how seafood safety inspection as part of fish control affects consumers' choices and their WTP, we focus on Rui to isolate the effect of a specific consumer choice. We use an experimental research design to collect data, with direct interviews with randomly selected households. The data were collected in Dhaka and Chittagong (see Fig. 1), which are chosen because their per capita fish consumption is higher than that of other cities in the country (Needham and Funge-Smith, 2014). Furthermore, as the capital city, Dhaka makes a significant contribution to the country's economy and is characterised as the 'Business Hub of Bangladesh,' and the commercial and port city of Chittagong makes a crucial contribution to foreign trade. Furthermore, people living in these cities are relatively wealthy compared to those in the rest of the country. These cities are thus suitable for our attempt to explore the growing consciousness of food safety control in emerging markets (HIES, 2016).

To construct a representative sample, we employ stratified cluster sampling processes. The fieldwork in the two study areas was undertaken from 12 January to 27 March 2019. Before the final version of the survey was completed, we conducted a pre-test survey of 42 subjects from Dhaka and 36 from Chittagong to confirm that they understood the questions and that there were no semantic or measurement problems. We found no significant obstacles, and the same settings were employed for the final version.

The primary respondents are household members older than 21 in charge of what other household members eat; these householders are more likely to be responsible for fish buying than others in the family. The purpose of the research was specified in a motivational letter to the participants, who were interviewed in the local language, Bengali, and answered a set of questions and responded to the survey. On average, each interview took 20 min. Before beginning the survey, the survey's contents were reviewed and approved by the Ethical Review Board, University of Chittagong, Bangladesh.

The first section of the questionnaire (see Appendix A) centred on fish choice based on fish attributes focused on fish safety control. Six sets of choices were presented in a table, and the respondents were requested to choose one from each (see Fig. 2). In each set, three fish options with four attributes were presented to assess consumers' choices. Furthermore, we included an additional 'opt-out' choice in each selection to allow for none of the other choices being found suitable. The choices in the experimental design were affected by the fish production method (wild, inland farmed, coastal farmed); the product form (fresh, frozen, iced); type of food safety inspection (national authority, local authority, no authorised safety inspection); and price per kg of the Rui (BDT 360,

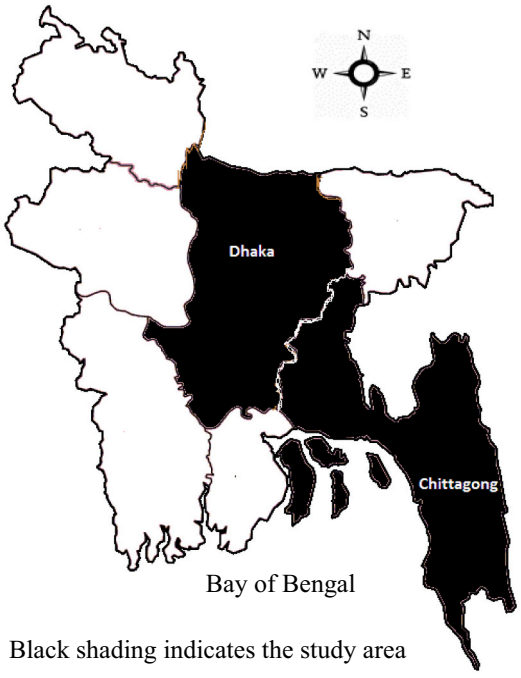

Fig. 1. The study area.

Imagine you are in the market and would like to buy 1 kg of the Rui you usually buy. Do you choose Option A, Option B, Option C or Option D?

Election number- #	**Option A**	**Option B**	**Option C**	**Option D**
Attribute				
Production method	Wild	Coastal farmed	Wild	None of these
Product form	Frozen	Iced	Iced	
Food safety control	No authorised safety inspection	National-level food safety inspection	Local-level food safety inspection	
Price/kg	BDT 200	BDT 360	BDT 280	
I would choose:	☐	☐	☐	☐

Fig. 2. Example of a choice set.

BDT 280, BDT 200) (see Table 1). A focus group discussion was arranged to ensure the estimated values were logical and relevant to the local economy to accurately estimate the fish attributes and alternatives. Based on time and budget constraints, 450 households were targeted as respondents. Of these, we omit 28 as they provided partial or incomplete information. Therefore, a total of 422 households are included in the between-subject design. The sampling distribution is as follows: Dhaka south ($N = 113$); Dhaka north ($N = 100$); Chittagong south ($N = 103$); and Chittagong north ($N = 106$). Ultimately, we obtain a data set of $n = 422 \times 6 \times 4 = 10{,}128$ observations.

With four factors and three levels, a total of 3^4 (81) hypothetical products can be created by connecting the attributes listed above. For useful analysis, the study employs an orthogonal fractional factorial design. The computer program SPSS (Version 26) provides the minimum number of six choice sets, with 18 product profiles. Following Balcombe et al. (2010), the participants were instructed to think about the choice scenarios as if they were real. We used a text script in the questionnaire to provide relevant information on fish attributes during the choice experiment to reduce the bias that could result from a hypothetical experiment (Murphy et al., 2005).

When buying fish, the attributes perceived by consumers affect their preferences. When they value a product and judge the quality of its attributes accurately, they will buy it (Caswell, 1998). Accordingly, how consumers perceive fish attributes is assessed with a simple attitude ranking survey, in which their valuing of fish attributes are assessed on a seven-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), thus revealing their perceptions of what the attributes meaning. Scores of four or five are treated as a neutral perceived value, scores of three or below are considered a negative perceived value and scores of six or above represent a positive perceived value (Hoque, 2020). However, in the Likert-type statements, the respondents could rate all the attributes as equally important (Phillips et al., 2002). Therefore, to gain in-depth insights, their evaluations of fish attributes are assessed in an attitude ranking survey (see Appendix A).

Hence, consumers ranked the fish attributes according to their perceived role in their fish choice from 1 (*most important*) to 4 (*least important*). Preference ranking can also effectively elicit consumer valuation based on conjoint analysis (Millar and Millar, 1996; Phillips et al., 2002). However, attitude and preference ranking involve different theoretical frameworks and methods. Therefore, we then also compare the outcomes of the two approaches to determine the relative importance of each fish attribute ranking. The relative importance of attributes is measured by the ratio of the range of utility (e.g., Rank 1) change for different attribute levels to the sum of such fields for all fish attributes.

Table 1
Fish attributes and levels for the choice experiments.

Fish attribute	Description	Levels/Alternatives
Production method	The fish come from seas, rivers, and other natural bodies of water. Alternatively, they can be raised in inland ponds or other freshwater bodies, in coastal areas in brackish water, or in the sea in saline water.	Wild-caught, inland-farmed, coastal-farmed.
Product form	The nature of the product purchased by consumers.	Fresh, frozen, iced.
Fish safety control	A regulatory activity (e.g., safety inspection) by an authority (national or local) that provides consumer protection and ensures that during production, handling, storage, processing and distribution of the fish is safe.	National-level food safety inspection (NFSI); local-level food safety inspection (LFSI); and no authorised food safety inspection (NoFSI)
Price	This is an economic indicator of the cost of purchase and what consumers would pay for one kg of fish. Here it is denoted in the Bangladeshi currency, globally coded as BDT (Bangladeshi taka).	BDT 360/kg, BDT 280/kg, BDT 200/kg

5. Econometric model

In economics and marketing, conjoint analysis is widely used to assess and estimate consumers' preferences and demand for market goods (Anderson and Sofia, 1993). In this study, we consider consumers' perceived value of food safety inspection and fish attributes, together with their fish-shopping experiences in a conjoint experiment. Generally, an individual chooses an alternative (the most preferred item) to maximise their utility, and other options are not chosen, indicating their mutual exclusiveness (Train, 2009a, 2009b). When respondent n observes choice set k with j alternatives, then the utility of alternative j for respondent n can be defined as:

$$U_{nkj} = x'_{kj}\beta + \varepsilon_{nkj} \quad (1)$$

where β represents a vector of the importance of the attributes (x) for consumers in assessing their utility. The error term ε_{nkj} captures the influence on the respondent's utility of unobserved factors. Respondents had four choices: Option A, Option B, Option C, and Option D (do not buy either). Thus, a conditional logit model is used to estimate the preference (Hensher et al., 2005; Roheim et al., 2012) where the probability of respondent n choosing product j of choice set k can be written as:

$$P_{nkj} = \frac{e^{\beta_j x_j + \gamma_{nj} x_j z_n}}{\sum_k e^{\beta_j x_j + \gamma_{nj} x_j z_n}} \quad (2)$$

In the economics literature, it is common to use the discrete choice model to choose between several alternative products (Train, 2009a, 2009b). This mathematical function predicts an individual's choice based on relative attractiveness or utility (Mehndiratta, 1997). This model provides an analytical advantage; the logit model is often used for

modelling the relationship between a categorical outcome and one or more numerical or categorical predictor variables. As a popular and widely used logit model, the MNL model generalises the logistic regression to more than two problems, providing log odds of the nominal outcome as a linear combination of the predictor variables that estimate a consumer's choice based on relative attractiveness or utility (Mehndiratta, 1997). The MNL model implicitly assumes independence from irrelevant alternatives (IIA) where violation of the IIA assumption is not a serious shortcoming (Guadagni and Little, 1983). In this study, the household choice for whole Rui is modelled using the disaggregate fish demand approach with a generic MNL model, in which the probability that respondent n chooses alternative j of choice set k is

$$P_{nkj} = \frac{exp\left(x_{kj}^{'}\beta\right)}{\sum_{i=1}^{J} exp(x_{ki}^{'}\beta)} \quad (3)$$

In addition, if the N respondents evaluate the same set of k choice sets, the log-likelihood function for the MNL model becomes:

$$ln(L(\beta)) = \sum_{n=1}^{N}\sum_{k=1}^{K}\sum_{j=1}^{J} y_{nkj} ln\left(P_{nkj}\right) \quad (4)$$

In Eq. 4, the dummy variable y_{nkj} equals one when respondent n prefers alternative j from choice set k, and zero otherwise. Individually respondents' choices are linked to individual-specific explanatory variables (Franses and Paap, 2001). These denote the ratio of the probability of choosing the options and the value of the various fish attributes, such as wild, inland farmed, fresh, food safety inspected. The responses in each choice set from four unlabelled options (1 = Option A, 2 = Option B, 3 = Option C, and 4 = Option D) is truncated into a multivariate binary choice exposing generic model (Hoque, 2020). For instance, the six multivariate dummy variables for the six responses were coded as equal to one if Option A is chosen and zero otherwise. Nonetheless, in the choice sets, as 'Option D' is 'None of these' and that the alternative specific constant (ASC) is equal to one when 'Option A', 'Option B', and 'Option C' is chosen, and zero if 'Option D'. Based on Eq. (4), the maximum likelihood estimates $\widehat{\beta}$ for the parameter and the vector are obtained by maximising the log-likelihood function, indicating that the parameters estimated in the model are useable for the probability of making a choice. A positive parameter suggests that the explanatory variable is likely to increase the likelihood of choosing the respective fish attribute. A negative parameter indicates that the predictor value tends to curtail the choice probability (Zhang et al., 2010).

Marginal values based on estimated parameters reflect the WTP for product attributes. According to Train (2009a, 2009b), the estimate can be calculated as the negative ratio of the coefficient of an attribute variable ($\beta_{attribute}$) to the price coefficient (β_{price}); the formula is as follows:

$$\mathrm{WTP}_{attribute} = -\frac{\beta_{attribute}}{\beta_{price}} \quad (5)$$

Consumers' WTP is accounted for by choice modelling (Model 2), which is measured hypothetically. Each marginal value represents consumers' WTP for a particular attribute related to the specific fish types while holding all else constant.

6. Results

The participant demographics and socioeconomic variables are presented in Table 2. Of the participants, most are male (78%), aged between 30 and 39 years old (40%), and with more than 12 years of education (83%). Culturally, men in Bangladesh (almost 80% in this case) are responsible for purchasing food for their families (Schaetzel et al., 2014). Most households (70%) have children and between two and five family members in total (77%). The mean monthly income of 30% of the respondents is between BDT 30,000 and BDT 50,000 (US$ 1 = BDT 84). Only 6.60% of the respondents are housemakers, while 54% are employed.

Table 2
Descriptive statistics of the demographic and psychographic variables and the preference patterns for whole rui.

Sample size (households)	n = 422
Age (%)	
20 to 29	10.70
30 to 39	39.80
40 to 49	30.10
50 to 59	13.50
60 to 69	05.70
70 or older	00.20
Gender (%)	
Male	78.20
Female	21.80
Education (%)	
0 to 5 years	02.80
5 to 12 years	13.50
Over 12 years	83.60
Children (age 1–16) in the household (%)	
Yes	70.40
No	29.60
Number of family members (%)	
Fewer than 2	02.10
2 to 5	77.00
Over 5	20.90
Household monthly income in Bangladeshi Taka (BDT) (%)	
Under 30,000	17.10
30,000 to 50,000	29.90
50,000 to 70,000	20.90
70,000 to 90,000	14.70
Over 90,000	17.50
Profession (%)	
Jobholder	54.00
Businessperson	21.60
Housemaker	06.60
Direct services	16.10
Other	01.60
Overall fish consumption (%)	
Once per month	00.50
Once per week	09.70
Several times per week	65.40
Daily	24.60
Do you do fish shopping for your family? (%)	
Yes	79.10
No	20.90
Where do you buy the fish? (%)	
Wet Market	51.70
Supermarket only	01.70
Both	46.70
Registered member of an environmental club (%)	
Yes	8.10
No	91.90
Existence of a high value of food safety inspection among those respondents who are environmental club members (%)	
Yes	67.65
No	32.35
Percentage of fish that consumers buy from supermarkets (mean ± St. dev.)	14.92 ± 20.78
N = 10,128	

A monthly income of less than BDT 50,000 is low, 50,000 to 89,000 is medium, and 90,000 and above is a high level of income. Fish consumption once per week is low, several times per week is medium, where daily is high.

The descriptive statistics also show that 65% of the households eat fish several times per week, and 25% do so daily. Almost 80% of the respondents do fish shopping for their families, with 52% buying their fish from a wet market. The results also reveal that very few respondents (8%) are registered members of any volunteer environmental organization or club. Approximately 15% of the total fish purchased were bought from supermarkets.

This study investigates the effects of product attributes, interactions between the attributes, and socioeconomic variables on the choice of whole Rui through two econometric models. As specified in Eqs. (2,3),

the conditional logit (CL) model and MNL regression are estimated to measure the impact of the attribute variables on fish choice, with the results reported in Table 3. Both the CL and MNL analyses first test the model fit by examining the chi-square of the final model (see Table 3, final row). Eq. (4) illustrates the estimated parameters in the MNL model; these are the marginal effects of the observed explanatory variables on the logarithm of the success odds ratio. The odds ratio shows the exponential outcomes of the corresponding parameters. As the sign and magnitude of the two models' coefficients are almost identical, we consider Model 2 with ASC for ease of analysis. The outcomes demonstrate that the ASC is insignificantly positive, meaning that, overall, consumers prefer whole fish. However, the odds of the price are −0.005, which is significantly negative, implying that consumers' preferences for whole fish would be lower at a higher price. (See Table 4.)

The individual parameter estimates show that, in response to the coastal-farmed version, wild fish are valuable in increasing the utility of consumers, as evidenced by their willingness to pay a price premium of BDT 299.20/kg. This finding is in line with Hoque (2020) for Bangladesh

Table 3
Estimated results of the exp. (coef) of product attributes and socioeconomics, and consumers' preferences.

Explanatory variables	Choice of whole rui in the					
	Conditional logit (CL) model			Multinomial logit (MNL) model		
	Model (1) with fish attributes, interactions between the attributes and socioeconomic variables			Model (2) with fish attributes, interactions between the attributes and socioeconomic variables		
	Coef	WTP	CI	Coef	WTP	CI
ASC	–	–	–	0.040 (0.356)	8.00	[−135.62, 151.62]
Wild	1.395*** (0.194)	348.75	[108.11, 589.38]	1.496*** (0.195)	299.20	[123.32, 475.07]
Inland-farmed	0.732*** (0.196)	183.00	[51.86, 314.13]	0.786*** (0.198)	157.20	[58.22, 256.17]
Fresh	0.237 (0.178)	59.25	[−51.66, 170.16]	0.243 (0.183)	48.60	[−39.42, 136.62]
Frozen	−0.901*** (0.222)	−225.25	[−368.11, −82.38]	−0.943*** (0.226)	−188.60	[−295.18, −82.01]
NFSI	0.506** (0.245)	126.5	[−10.27, 263.27]	0.259 (0.163)	51.80	[−15.67, 119.27]
NoFSI	−3.829*** (0.606)	−957.25	[−1490.53, −423.96]	−3.927*** (0.608)	−785.40	[−1155.53, −415.26]
Price	−0.004*** (0.001)	–	–	−0.005*** (0.001)	–	–
Opt-out	−2.221*** (0.353)	−555.25	[−719.81, −390.68]	−2.368*** (0.362)	−473.60	[−571.22, −375.97]
Wild*Fresh	1.254*** (0.300)	313.50	[203.48, 423.51]	1.355*** (0.309)	271.00	[190.02, 351.97]
Wild*Frozen	1.715*** (0.289)	428.75	[229.46, 628.03]	1.818*** (0.296)	363.60	[223.61, 503.58]
Wild*NoFSI	1.205** (0.601)	301.25	[−44.27, 646.77]	1.074* (0.603)	214.80	[−48.48, 478.08]
Inland-farmed*Fresh	0.479** (0.239)	119.75	[−29.62, 269.12]	0.526** (0.246)	105.20	[−13.72, 224.12]
Inland-farmed*Frozen	0.268 (0.275)	67.00	[−86.38, 220.38]	0.254 (0.281)	50.80	[−71.90, 173.50]
Inland-farmed* NoFSI	0.533 (0.681)	133.25	[−207.91, 474.41]	0.504 (0.684)	100.80	[−173.75, 375.35]
Wild*High income	−0.026 (0.126)	−06.50	[−71.64, 58.64]	−0.020 (0.113)	−4.00	[−50.41, 42.41]
Inland-farmed*Medium income	−0.374** (0.158)	−93.50	[−187.30, 00.30]	−0.410*** (0.150)	−82.00	[−151.88, −12.11]
Coastal-farmed*Low income	0.174 (0.137)	43.50	[−30.21, 117.21]	0.190 (0.125)	38.00	[−15.79, 91.79]
Price*Wet market	−0.002*** (0.000)	−00.50	[−00.90, −00.09]	−0.0004* (0.000)	−0.08	[−0.18, 0.022]
Price*Supermarket	−0.003 (0.002)	−00.75	[−01.74, 00.24]	−0.001 (0.001)	−0.20	[−00.57, 0.170]
NFSI* High income	−0.005 (0.123)	−01.25	[−64.43, 61.93]	−0.006 (0.110)	−1.20	[−46.57, 44.17]
LFSI*Medium income	0.272* (0.143)	68.00	[−13.16, 149.16]	0.285** (0.129)	57.00	[−0.83, 114.83]
NoFSI*Low income	−0.482** (0.195)	−120.50	[−237.63, −3.36]	−0.492*** (0.189)	−98.40	[−185.78, −11.01]
NFSI* High consumption	−0.150 (0.236)	−37.50	[−160.96, 85.96]	0.125 (0.148)	25.00	[−36.76, 86.76]
LFSI*Medium consumption	0.578** (0.242)	144.50	[−00.65, 289.65]	0.326** (0.153)	65.20	[−3.23, 133.63]
NoFSI*Low consumption	0.715 (1.180)	178.75	[−435.44, 792.94]	0.665 (1.130)	133.00	[−335.50, 601.50]
Number of observations = 10,128, Number of groups = 422	Pseudo-R^2 = 0.3048, LR Chi^2 (25) = 3038.41, Prob. (Chi^2) = 0.000			Pseudo-R^2 = 0.2791, LR Chi^2 (25) = 3179.00, Prob. (Chi^2) = 0.000		

Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$. Parameter estimates from the MNL model; ASC = Alternative Specific Constant; NFSI = National-level Food Safety Inspection; LFSI = Local-level Food Safety Inspection; NoFSC = No authorised Food Safety Inspection; WTP, standard error (S.E.), and confidence interval (C.I.) estimated with the delta method.

Table 4
The relative importance of fish attributes (Numbers in parentheses indicate ranking).

Framework for Operationalisation and Conceptualisation		Attribute				Total
Operationalisation of safety inspection	Types of rankings and their characteristics	Price	Production method	Product form	Safety inspection	
Relative importance (based on the most important attribute in fish choice; 1=yes, 0 = otherwise)	Attitude ranking: direct experiences, affective reactions, consummatory behaviour, intrinsic enjoyment.	9.95 (4)	47.14 (1)	13.94 (3)	28.97 (2)	100.00
Relative importance (based on the predicted expected utility from fish attributes)	Preference ranking: indirect experiences, cognitive reactions, instrumental behaviour, cognition and beliefs.	−0.79 (3)	432.36 (1)	151.19 (2)	−482.75 (4)	100.00

and Uchida et al. (2014) for Asia and is consistent with studies in Europe and the Americas (Holland and Wessells, 1998; O'Dierno et al., 2006; Wirth et al., 2007; Davidson et al., 2012; Nguyen et al., 2015; Rickertsen et al., 2017a, 2017b).

Compared to the coastal-farmed version, inland-farmed fish also significantly increase the utility of consumers, who are willing to pay a price premium. The literature reveals that consumers prefer inland freshwater to sea fish (Galib, 2011), whereas a more significant number of North Carolina consumers prefer saltwater-farmed seafood (Drake et al., 2006). In Europe, the value consumers place on farmed fish is positively related to food safety (Claret et al., 2014). Most consumers perceive no difference between farmed and wild fish, with availability a salient feature of a preference for the former (Verbeke et al., 2007; Claret et al., 2014). However, consumers' WTP is much higher for wild than farmed fish (Davidson et al., 2012).

Second, the results reveal that in response to iced fish, the utility of fresh fish increases for consumers and their marginal WTP is positive. Consumers' preference for fresh fish is also consistent with previous studies in both developed and developing economies, such as India (Debnath et al., 2012), China (Hu et al., 2014), Kenya (Musa et al., 2012), France (Nguyen et al., 2015), Denmark (Stubbe Solgaard and Yang, 2011), and Malaysia (Ahmad Hanis et al., 2013). Freshness is also an essential attribute for Asian consumers in the Northeastern United States (Thapa et al., 2015). In addition, in comparison to iced fish, frozen fish decreases the utility of whole rui for consumers, meaning they are only willing to buy it at a reduced price. This result is consistent with Davidson et al. (2012).

Third, in response to the food safety inspection of local authorities, NFSI does not significantly increase fish utility. Moreover, compared to local-level inspection, not having an inspection greatly reduces the utility of fish for consumers. The results also demonstrate that consumers' WTP for NoFSI is negative, and more significantly so than the WTP of the opt-out group. With either no or inadequate food safety regulation, consumers are unable to assess fish products (Lawley et al., 2012). Again, a high price premium was recorded for farmed fish with Aquaculture Stewardship Council certification (Xuan, 2021). It appears the application of scientific national-level food safety regulations are required to meet world-class safety standards (Cato, 1998).

In this study, the effects we consider are those be analysed by creating interaction terms between product attribute variables (Davidson et al., 2012). Without these interacted terms, the results can be interpreted as capturing the average perceived value of the product attributes for the sample (Train, 2009a, 2009b). In the interaction analysis, the interaction of production method and product form could provide substantial information for consumer food-product utility. For instance, the wild and fresh attributes together increase consumers' utility, indicating they are complementary. As the attributes increase utility individually, it is expected that together they will increase consumers' utility. Such a finding is relevant to the outcomes of Roheim et al. (2012).

Furthermore, the wild and frozen attributes are valued individually and increase or decrease consumers' utility, respectively. However, this attribute information significantly increases consumers' utility when the attributes wild and frozen are provided together. This indicates they are complementary and that consumers have a strong preference for wild fish in the frozen form. Individually, the NoFSI attribute reduces the utility of fish for consumers. When this and the wildness attribute are considered together, wild fish significantly increase consumer utility, but the inland-farmed version does not. A recent study in France also shows that consumers perceive wild fish as best for safety and health (Rickertsen et al., 2017a, 2017b). However, it is only in the fresh form that the inland-farmed version increases utility; consumers are willing to pay a price premium of BDT 105.20/kg.

The model's interaction effect also shows that high-income consumers are willing to buy wild fish at a low price. The significant negative interaction effect between inland-farmed fish and a medium level of income implies that they are substitutes; the coastal version increases utility to consumers insignificantly, but they are willing to pay a price premium of BDT 38.00/kg. Previous studies demonstrate that both inland- and coastal-farmed fish significantly benefit Bangladeshi consumers (Hoque et al., 2021b). In addition, the interaction term between price and the wet market is negatively significant, meaning that consumers are willing to buy whole fish in the wet market at a low price. Presently, compared to wet markets, modern retailers (e.g., supermarkets) sell higher quality products at higher prices (Schipmann and Qaim, 2011).

The model's interaction effect also indicates that a positive and significant interaction term between LFSI and a medium level of income is significantly positive and complementary. In this complementary effect, LFSI increases the utility of fish to consumers. Due to the introduction of local GAP standards, minimum food safety and hygiene is required for the control of the marketplace (Havinga et al., 2015, p.78). The China Food and Drug Administration has introduced local governance regulations to develop a legal and regulatory system to address food safety risks (Jensen and Zhou, 2015, p.181). Similarly, in terms of fish consumption level, consumers are most likely to prefer LFSI. On the other hand, fish with NoFSI produces consumer disutility, in which the effect of NFSI is insignificantly negative.

Although consumers value the production method as the most important attribute in fish choice (in the attitude rating and ranking), their perceptions of food safety were heterogeneous. Consumers weighted safety inspection as second in the rating (see Fig. 3) and third in the attitude ranking. More mental effort is required to answer ranking than rating questions (Verint, 2013). This neurocognitive process reflects the psychological cost (e.g., mental concern or mental resistance) of information processing during perception (Logan, 2019). The outcomes demonstrate that in the attitude ranking, where a high mental cost (friction or anxiety) is involved in responding, consumers perceive a lower value for food safety inspection than in the attitude rating. This indicates that consumers prefer safety information that is legible, clearly and consistently presented and with a low mental processing cost. Food safety regulators that develop educational materials should thus include the required safety information to reduce consumers' mental costs, to obtain strong form efficiency in the fisheries and aquaculture market.

In comparing two attitude objects, attitude ranking is superior to attitude rating (Anne-Wil et al., 2009). Attitude rankings represent

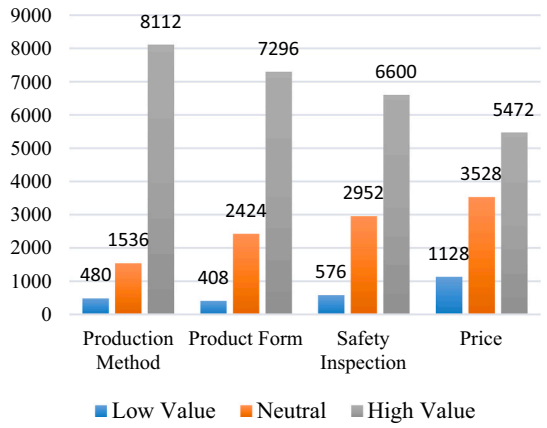

Fig. 3. Percieved value of fish attributes which affect their fish choice.

consumer's direct experiences of attitude objects that might produce affective reactions linked to consumer behaviour and directly influence their preferences (Millar and Millar, 1996; Phillips et al., 2002). Such behaviour greatly affects consumers' consideration of product attributes and their intrinsic enjoyment of the consumption (Millar and Millar, 1996). Consumers value the method of fish production and food safety inspection as the first and second most crucial fish-choice attributes (see Fig. 4, Table 3).

In the preference ranking, consumers perceive fish attributes indirectly by means of predicted objects that produce cognitive reactions linked to their instrumental behaviour (Millar and Millar, 1996; Phillips et al., 2002). This behaviour allows consumers to form their attitudes to fish attributes based on cognition and beliefs rather than affectively driven actions and intrinsic enjoyment (Millar and Millar, 1996; Hoque and Hossan, 2020; Hoque et al., 2018). In such instrumental behaviour, consumers perceive the fish production method to be most important, with safety inspection as the fourth most important attribute. However, they perceive fish safety inspection as the second most crucial attribute in attitude ranking in relation to their consumption behaviour. Therefore, consumers' perception of fish safety inspection related to their affective reaction for intrinsic enjoyment is higher than their reactions based on cognition and beliefs. Such a low belief perception of fish safety inspection indicates that Bangladeshi consumers' do not have a high level of belief in the existing fish safety control, with affective drivers greatly influencing their consumption of fish at a high rate. From the affective perspective, fish and fishery products have a strong association with national pride, upbringing, and a sense of belonging to the community (Hoque et al., 2021b), which helps make Bangladesh a fish-eating nation.

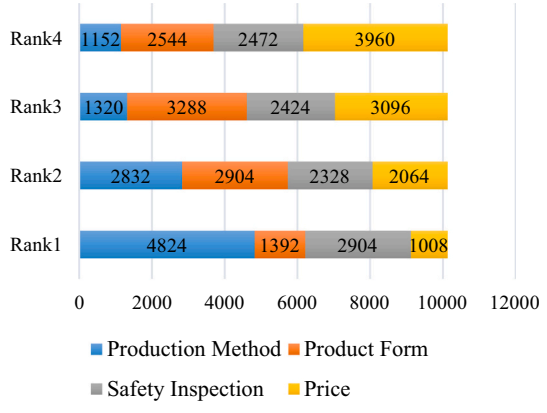

Fig. 4. Rank distribution of the four attributes according to the importance in consumers' fish choice.

7. Discussion

Bangladesh has a high-level frequency of fish consumption, and consumers' fish choices are heterogeneous. Generally, consumers prefer wild fish to the farmed version, and they are willing to pay a price premium for wild fish for its positively valued taste and safety attributes. Even a lack of authorised safety inspections increases consumers' utility from wild fish, clearly suggesting that they find wild fish safe; the existing food safety inspection is not required by consumers. Individually, the attribute 'fresh' increases consumers' utility insignificantly, while that of attribute 'frozen' decreases utility significantly. Interestingly, when the attributes of production method and product form are combined, consumers value wild fish in frozen form more than in fresh form, indicating their strong preference for wild fish, irrespective of the product form (fresh or frozen).

Many wild fish are caught at sea, and the process from the point of catch to the table is relatively long. Therefore, it is not easy to find wild fish in fresh form. Such inconvenience in obtaining wild fresh fish leads consumers who prefer the wild version to mostly depend on the frozen alternative. In addition, in the urban areas of Bangladesh, fish produced in inland freshwater is treated as local, indicating a similar attitude to consumers in European and the Mediterranean (Jaffry et al., 2004; Brécard et al., 2009; Claret et al., 2012; Mauracher et al., 2013), in their preference for locally farmed fish (e.g., inland freshwater fish) over coastal- and marine-farmed versions (Hoque et al., 2021a, 2021b).

In addition to the fish production method (wild vs farmed), the fish form (fresh vs frozen) also plays a vital role in consumers' fish choices. When the attribute 'fresh' is considered alone, it increases consumer utility. However, consumers are less likely to prefer the frozen fish, indicating they are willing to pay a premium for the fresh fish. Alternatively, they are willing to buy the frozen fish product at a lower price. These findings imply that whole fish in fresh form will be popular in local Bangladeshi markets.

Furthermore, a new form of fish or a new measure for frozen fish is required to increase fish utility to consumers. Despite the market opportunities for new fish products, Bangladeshi consumers traditionally have a fixed affinity for consuming the fish available in local markets. They have already formed the habit of eating fish, with a high level of affection for fish consumption (Hoque, 2020). As the supply of fresh fish is limited, to meet the high demand, consumers also prefer alternative fish forms, such as frozen, iced, and dried.

Bangladeshi consumers are highly experienced in handling and processing whole fish. There is also a fish-handling service available for a fee at the point of sale, which motivates people to eat whole fish. Therefore, consumers have a marked preference for whole inland-farmed fish in fresh form. In addition, they assume frozen farmed fish traded in the local markets is below average in terms of taste and safety. Although consumers' WTP for farmed fish in frozen form is positive, the availability of such fish will not significantly increase the number of buyers.

An effective trading strategy is required for farmed frozen fish, for example, authorised food safety inspections; these may help to significantly improve consumer's utility from fish. Farmed fish is not considered suitable in terms of health and safety, but it may be the best option for environmental sustainability and fish welfare (Rickertsen et al., 2017a, 2017b). Although farmed fish raises food safety concerns, there is a tendency to underestimate food safety risks. This factor, a high level of demand for fish, and a certain affinity for fish consumption (e.g., ASC), mean that consumers are willing to pay a premium for inland-farmed fish.

Surprisingly, consumer's WTP for non-inspected inland-farmed fish, which is the status-quo (BDT 100.80), is higher than for inland-farmed frozen fish (BDT 50.80). It is notable that consumers in traditional market outlets perceive a low level of food health risk (Hoque et al., 2021b). Because there is a limited or absent supply of safety-inspected fish, even the absence of an authorised food safety inspection may

increase consumers' utility from fish in the domestic market. Such a conventional or uninspected fish preference may be one kind of forced choice. In the absence of the preferred seafood and its unsuitable substitutes, in developed countries, consumers do not buy any fish product at all (Carlucci et al., 2015); however, this is not applicable in an emerging economy such as Bangladesh. Consumers' high level of fish consumption and established habits may influence them to prefer whole finfish, even if no safety inspection has been made. However, due to the higher levels of income and education now prevailing, Bangladeshi urban households are becoming gradually more conscious of food safety and sustainability in their fish choices (Hoque, 2020).

As food security and safety are vital, and fisheries and aquaculture are essential in the food economy, a fish safety system is now central and provides opportunities for consumers to estimate their demand for fish that is safety-inspected that which is not. In local Bangladeshi markets, NFSI increases fish utility to consumers. NoFSI decreases consumer utility from fish, clearly implying that for consumers wanting safe farmed fish, the existing or additional food safety inspections are mandatory. Although food elements should be labelled and the necessary information provided to consumers, this is not the case in local fish markets, specifically in wet markets in Bangladesh (Hoque, 2020). Therefore, consumers' overall value of fish safety in Bangladeshi local markets is low, and they are only willing to buy whole rui in the wet market at a lower price.

Although preferences and perceptions are key elements in the analysis of market demand, price and income are also important issues. The parameter estimates show that, based on income, consumers are less likely to prefer inland-farmed fish, meaning that they are highly price-sensitive to farmed fish. Therefore, because of the higher price of inland-farmed fish, consumers choose coastal-farmed fish. Food safety is a vital information cue when buying fish (Pieniak et al., 2013); however, consumers are rarely able to find any safety information when buying fish in Bangladeshi local markets.

Additionally, to boost the lifespan and appearance of fish, it is common practice for vendors to spray fish with chemical preservatives, including formalin (Goon et al., 2014). As a result, consumers are suspicious and worried about fish safety, and fish farmers face the challenge of having to engage in communication campaigns because of the low consumer loyalty to their products (Gaviglio, 2009). The overall negative evaluation of the Bangladeshi fisheries sector posing a significant threat to households' income and food security and requires immediate action by policymakers (Ghose, 2014). The results also show that LFSI increases fish utility to consumers, and their MWTP is positive. However, our most interesting finding is that consumers are less likely to prefer fish with NoFSI, meaning they expect active and reliable safety inspections. The research shows that in terms of safety and hygiene issues, production methods, and nutrition value (Claret et al., 2016), the availability of information also influences consumers' fish preferences (Siret and Issanchou, 2000). Such findings in the literature confirm that whole fish with LFSI will be popular in local markets in emerging economies such as Bangladesh.

Currently, Bangladeshi market food safety issues are causing a severe crisis of trust, and the existing national-level certification system for food safety (e.g., BSTI approved) is extremely inefficient (Hoque et al., 2021b). Even the government has not verified this scheme through consumers, and many substandard food products have been found labelled as 'BSTI approved'. Additionally, many counterfeit food products are traded in the local markets cynically labelled with the warning "Beware of fake products" (Hoque, 2020). Therefore, to increase consumers' trust level, Bangladesh's food safety regulators should provide unique inspection resources to supervise the safety of fish and other seafood sold in ostensibly trustworthy markets and must not permit exemptions to inspections. In China, despite the inefficient safety certification system for milk (Zhang et al., 2010), consumers are willing to pay a premium for safe, traceable fish products over non-traced products of uncertain safety (Wang et al., 2009).

Another interesting finding is that consumers are not sensitive to food safety risks relating to fish consumption levels. Even with NoFSI, they prefer to consume a certain level of fish that is, in fact, higher than that preferred for fish with an NFSI. Such discrepancies in the perceptions of food safety risk may lead to potential market failures, despite the focus on a health-driven approach to food safety (Johan et al., 2013). On the one hand, consumers are concerned about food safety, and on the other, they underestimate the threats of safety risks, revealing a gap between their expectations and perceptions regarding food safety inspection (Lin et al., 2020). Such behaviour shows emotional responses to, or experiences of, fish consumption. These responses could be turned into emotional preferences and further the potential of fisheries and aquaculture (Hoque et al., 2021a) and support the cultural connotation of consumption "Fish eater Bangali (Mach-e-bhat-e-Bangali)".

People are reluctant to buy the greenest products (Young et al., 2010), with green consumers giving these low priority. Similarly, the introduction of LFSI for whole rui offers a policy approach to change consumer behaviour (Hoque, 2020). In recent years, a combined government and private monitoring mechanism has been introduced to improve seafood safety and restore consumers' trust in fishery products in Bangladesh (Economic Review, 2018). These are mostly reactive and based on completed fish product inspections. In addition, these reactive inspections are ineffective and poorly implemented. As the efforts are not complete or sufficient to ensure fish safety security in local markets, a preventive and risk-based inspection focusing on the entire fish chain should be implemented to better manage fish safety control. Such risk-based safety inspections could support the authorities in formulating an effective food safety policy with a proper institutional framework for its operationalisation (FAO, 2004) and resources allocated to the areas with the more significant safety risks.

8. Conclusion

We assessed consumers' perceptions of fish attributes using three different attitude measurement and scaling techniques: attitude rating, attitude raking, and preference ranking. The typical value of the fish attributes assessed across all estimation techniques indicates that the production method (wild or farmed) greatly influences people in their fish choice. A heterogeneous value for fish safety inspection suggests that consumers expect information regarding food safety control at a low mental cost. Consumers beliefs regarding fish safety inspections in safety control are low, whereas the effects of affection on fish choice are high.

Second, the results indicate that for most consumers, wild fish is still perceived as having better overall quality than the farmed equivalent. When consumers find it difficult to locate fresh wild fish in the marketplace, and if the price is relatively high, they are more likely to prefer frozen wild fish. Although wild fish may not involve food safety inspection, consumers are most likely to buy such fish. Interestingly, consumers prefer frozen wild fish to fresh wild fish because of its availability in the local market.

Third, only fresh-farmed fish increases consumer utility. Farmed fish in frozen form and with no authorised food safety inspection is not appealing but becomes attractive if there is a local-level food safety inspection. Alhough consumers have mixed perceptions of fish that has passed an NFSI, they are willing to pay a premium for fish with a local-level food safety inspection. This suggests the market potential for farmed fish if it is certified by the local authority. Interestingly, when no fish with a food safety certification is available, they are still interested in conventional or uninspected wild fish.

Consumers' WTP behaviour shows that they are willing to pay less for inland-farmed fish. Therefore, coastal-farmed fish could offer an alternative to meet the high demand from urban households. Additionally, inland fresh-farmed fish with a local municipality inspection would be an excellent alternative to scarce wild fish. This may support the claim that safety-inspected farmed fish could become prevalent in

Bangladeshi fish markets. More focus should be placed on the relative importance of consumers' preferences for particular attributes, such as production methods, product forms, food safety inspection authorities, and the potential interaction effect among fish attributes. Accordingly, effective information strategies addressed to the general public should be developed to support and increase farmed fresh fish and safe fish consumption. This would reduce the negative impact of traditional fish preservation practices on selling methods and reduce unsustainable fish consumption. Such outcomes and policy recommendations would provide essential information to cities such as Dhaka and Chittagong to improve Bangladeshi consumers' general perceptions of policymakers and major potential food traders (domestic and foreign).

In this study, we considered two major cities, covering the country's southern and central urban households; North Bengal was excluded. However, we suspect that the results would vary considerably for diverse geographical locations and cultures. For example, the preference for wild over farmed fish is likely to be improved in the west and southern parts, and the wild fisheries in the Bay of Bengal expanded. Therefore, it is not easy to generalise from our results. Another caveat is that the design of choice experiments varies from study to study, including concerning the range of prices used to cover the potential WTP. We employed stratified cluster sampling, which is a systematic tool, suggesting the results can be used to draw a more robust conclusion. Similar studies could be conducted in future that include food safety labelling and cover more of Bangladesh; these could potentially cover major urban areas to account for the significant differences between economic conditions in rural and urban households.

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Informed consent statement

Informed consent was obtained from all subjects involved in the study.

Data availability statement

The data presented in this study are available on request from the corresponding author.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. The questionnaire

Consumer Preference for Fish Safety Inspection in Bangladesh: A Survey Questionnaire-February 2019.

Dear Respondents,

This questionnaire survey is a part of my Doctoral research. This survey is about the choice of fish, and the aim is to measure the effect of food safety inspection and price on buying decision. Please fill in the first choice that comes to your mind since this is probably closest to your real purchase behaviour in markets. There are no risks or benefits related to filling in this survey, and all the information you provide remains very confidential. Notice, all data will be used anonymously for academic purpose as suggestions to estimate consumer preferences.

The survey is a direct interview method and mostly self-report choice questions. It will be divided into two parts. First, we will ask you to choose one type of fish among three alternatives in the six choice sets. In the second phase, we will ask to answer some demographic questions. It will take around 20 min to fill in this questionnaire.

Thank you in advance for your cooperation.

Best Regards,

Mohammed Ziaul Hoque.

PhD Fellow, School of Business and Economics (HHT).

Faculty of Bioscience, Fisheries and Economics.

UiT The Arctic University of Norway.

www.uit.no

*For any clarification, please, contact Mr. Hoque (+4,747,733,295; +8,801,716,584 124, https://www.facebook.com/ziaul.hoque.5492, mohammed.z.hoque@uit.no).

Section 1: Choice Experiment.

Instructions

- You will view details about three types of fish at a time on a choice card.
- Examine the design details—such as the variety of attributes or price—that you usually use to make a buying decision.
- Indicate which of the three fishes you would choose; only one choice is allowed. You can also indicate that you would not choose either fish in that particular three types.
- Please think carefully about each decision as though your choices were real.

Below is an example of a choice scenario:

Imagine you are in the market and will buy Rui fish that you usually buy: There are four choices A, B, C and D. You are asked to choose the one you would most likely buy. Again, only one option is allowed.

Example	**Option A**	**Option B**	**Option C**	**Option D**
Attributes				
Production method	Wild	Wild	Inland Farmed	None of these
Product form	Frozen	Fesh	Frozen	
Food safety control	National-level food safety inspection	Local-level food safety inspection	No-authorised safety inspection	
Price/kg	TK 200	TK 280	TK 360	
I would choose:	☐	☐	☐	☐

Fig. A1. Example of a choice set.

Please read the relevant text information regarding fish attributes carefully, then begin the survey:

- **Price:** Price of 1 kg of the type of fish you have selected (Bangladeshi Taka)
- **National-level food safety inspection**: A regulatory safety inspection by national authority to provide consumer protection and ensure that fishes during production, handling, storage, processing & distribution are safe. For instance, the regulatory functions of IPH (Institute of Public Health), Dhaka, and the BSTI (Bangladesh Standard Testing Institutions).
- **Local-level food safety inspection:** A regulatory safety by the local authority to provide consumer protection and ensure that fishes during production, handling, storage, processing & distribution are safe. For instance, the regulatory functions of the executive magistrate and health officer of Dhaka City Corporations and Chittagong City Corporations.
- **No-authorised safety inspection**: There is no authority to provide safety protection to consumers and ensure that fishes during production, handling, storage, processing & distribution are safe.

Now we will begin the survey; please tick (√) your choice in the following choice sets.

Election-1	**Option A**	**Option B**	**Option C**	**Option D**
Attributes				
Production method	Inland Farmed	Coastal farmed	Coastal farmed	None of these
Product form	Fresh	Fresh	Iced	
Food safety control	National-level food safety inspection	Local-level food safety inspection	No-authorised safety inspection	
Price/kg	TK 200	TK 200	TK 200	
I would choose:	☐	☐	☐	☐

Election-2	**Option A**	**Option B**	**Option C**	**Option D**
Attributes				
Production method	Inland Farmed	Wild	Coastal farmed	None of these
Product form	Fresh	Fresh	Iced	
Food safety control	National-level food safety inspection	Local-level food safety inspection	No-authorised safety inspection	
Price/kg	TK 200	TK 200	TK 200	
I would choose:	☐	☐	☐	☐

Election-3	**Option A**	**Option B**	**Option C**	**Option D**
Attributes				
Production method	Inland Farmed	Wild	Coastal farmed	None of these
Product form	Frozen	Fresh	Fresh	
Food safety control	Local-level food safety inspection	No-authorised safety inspection	National-level food safety inspection	
Price/kg	TK 200	TK 280	TK 280	
I would choose:	☐	☐	☐	☐

Election-4	**Option A**	**Option B**	**Option C**	**Option D**
Attributes				
Production method	Coastal farmed	Wild	Inland Farmed	None of these
Product form	Frozen	Iced	Iced	
Food safety control	Local-level food safety inspection	National-level food safety inspection	No-authorised safety inspection	
Price/kg	TK 280	TK 200	TK 280	
I would choose:	☐	☐	☐	☐

Election-5	**Option A**	**Option B**	**Option C**	**Option D**
Attributes				
Production method	Wild	Coastal farmed	Wild	None of these
Product form	Frozen	Iced	Iced	
Food safety control	No-authorised safety inspection	National-level food safety inspection	Local-level food safety inspection	
Price/kg	TK 200	TK 360	TK 280	
I would choose:	☐	☐	☐	☐

Election-6	**Option A**	**Option B**	**Option C**	**Option D**
Attributes				
Production method	Inland Farmed	Inland Farmed	Wild	None of these
Product form	Fresh	Frozen	Fresh	
Food safety control	No authorized safety inspection	National-level food safety inspection	Local-level food safety inspection	
Price/kg	TK 360	TK 280	TK 360	
I would choose:	☐	☐	☐	☐

Please rate the following statements by giving the tick mark on the best agreeing (one) option only.

Statements	**Strongly Disagree**	**Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Agree**	**Strongly Agree**
Production method (e.g., wild or farmed) affects my choice of fish	❶	❷	❸	❹	❺	❻	❼
Production form (e.g., fresh or frozen) affects my choice of fish	❶	❷	❸	❹	❺	❻	❼
Safety inspection affects my choice of fish	❶	❷	❸	❹	❺	❻	❼
Price affects my choice of fish	❶	❷	❸	❹	❺	❻	❼

Section 2: Personal Characteristics.

Finally, please rank the following four attributes according to the importance of your fish choice (1 = most important to 4 = least important).

a) Age: ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60-69 ☐ 70 years or older

b) Gender: ☐ Male ☐ Female

c) Income/month (Taka): ☐ <30,000 ☐ 30,000-50,000 ☐ 50,000-70,000 ☐ 70,000-90,000 ☐ > 90,000

d) Child (age 1-16) in household: ☐ Yes ☐ No

e) Number of family member: ☐ less than 2 ☐ 2 to 5 ☐ more than 5

f) Your education of years: ☐ 0 to 5 years ☐ 5 to12 years ☐ above 12 years

g) Your profession: _____

h) Do you do most of the food shopping for your family? ☐ Yes ☐ No

i) Overall fish consumption: ☐ Less-than once/month ☐ once/month ☐ once/week ☐ Several-times/week ☐ Daily

j) I buy fish from: ☐ Wet market ☐ Supermarket ☐ Both

k) In general, what is the percentage of fish that you buy from supermarkets? ☐ %

l) Are you a registered member of any environmental organization? ☐ Yes ☐ No

Finally, please rank the following four attributes according to the importance of your fish choice (1=most important to 4=least important)

Finally, please rank the following four attributes according to the importance of your fish choice (1 = most important to 4 = least important).

Attribute	Production method	Product form	Safety inspection	Price
Ranking				

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