Indian J. Fish., 71 (3): 140-148, 2024 doi:10.21077/ijf.2024.71.3.125543-17

Available online at: epubs.icar.org.in/index.php/IJF

Geospatial fish consumption patterns and paradigms in Odisha State, India

Shyam S. Salim[1], S. S. Raju[2*], N. R. Athira[1], Subal Kumar Roul[3], Phalguni Pattnaik[2] and L. Loveson Edward[2]

[1]ICAR-Central Marine Fisheries Research Institute, Kochi - 682 018, Kerala, India
[2]Visakhapatnam Regional Centre of ICAR-Central Marine Fisheries Research Institute, Visakhapatnam - 530 003, Andhra Pradesh, India
[3]Digha Research Station of ICAR-Central Marine Fisheries Research Institute, Digha - 721 441, West Bengal, India

Abstract

The current study investigated the geographic distribution and characteristics of fish consumption in Odisha State, India. The study was conducted across various locations, comprising urban coastal (Puri), rural coastal (Balasore), urban non-coastal (Cuttack) and rural non-coastal (Mayurbhanj) districts in the state. A total of 1440 respondents were selected for assessing the fish consumption patterns across theses diverse locations. According to the consumer profile, 82% of respondents were between the age of 20 and 50, with 24% having a college degree. More than 90% of the respondents reported that they consume fish regularly. The results indicated that increased fish availability (62%), accessibility (52%), and affordability (48%) contributed to a rise in fish consumption over time. Over all, distance to the fish access points ranged between 1 to 2. Catla was the most preferred fish species among consumers, followed by Rohu and other carps. Several barriers to increasing fish consumption were identified based on the perceptions of the respondents, such as erratic availability, lack of preference for fresh fish, wide price variations, limited access and high price. The data were analysed using a range of statistical and econometric methods, including conjoint analysis, preference assessment index and discriminant analysis.

*Correspondence e-mail:
shyam.icar@gmail.com

Keywords:
Coastal, Conjoint analysis, Discriminant analysis, Fish consumption, Non-coastal, Preference assessment index

Received : 11.07.2022
Accepted : 18.06.2024

Introduction

Fisheries sector plays very important role in the growth of national economy and continues to show an impressive growth rate when compared to other food producing sectors in the country. The sector focuses on enhancing fish production efficiency, improving welfare of fishermen, ensuring equity, boosting export and trade, creating jobs, and ensuring food security, each representing key economic paradigms. Fish is considered as a major constituent of the diet, serving both as an affordable source of protein for the poor and as a high-priced delicacy. Approximately 60% of Indians consume fish with consumption patterns varying across different regions and time periods, influenced by various social factors (Shyam 2013a).

For millennia, fish has been acknowledged as a great human food source and is valued as a complete diet (Shyam, 2013b) and as a crucial component of healthy diet (Shyam, 2016). Fish, on a fresh-weight basis, contains a good amount of protein, about 18-20%, as well as all of the important amino acids (Mohanty, 2011). This guarantees that the fishing sector contributes to attaining the Millennium Development Goals (MDGs: Goals 4 and 5 (decreased infant mortality and improved maternal health). The significance of nutritional components of fish has been supported by research over the last few decades. Fish may also help avoid illnesses, and there is substantial evidence that it plays a significant role in preventing heart disease (Shyam *et al*., 2021).

The fish demand and supply relationship are very closely related to fish availability, accessibility and affordability. The quality of the fish must not be compromised by long-distance travel or the use of additives given its local accessibility. Accessibility assumes significance as the consumers

need not have to travel long to purchase fish and ideally it should be available nearby. Affordability on the other hand, is influenced by various factors including species, size, time, product form and fishing methods as well as seasons. With a *per capita* fish consumption 2.5 times higher than the national average, Odisha is one of the major fish-producing and consuming states in India. It is of significance to examine whether the fish consumption in Odisha is impacted by the factors of fish availability, accessibility and affordability. The current study explores fish consumption trends and patterns across the selected study areas in Odisha, identifying key features and barriers faced by consumers. The primary goal of this study is to assess if there are cross-cultural differences in fish consumption between households in the coastal and non-coastal regions of Odisha. This study also delves into a comparison of the coastal and non-coastal fish consumption status of the state. The overarching goals are to examine various dimensions of fish consumption in the four study locations, with emphasis on analysing the consumption trends, patterns, identifying the key motivators for fish consumption and evaluating the main constraints that affect fish intake.

Materials and methods

The study was based on primary information acquired from four districts in Odisha that included both urban and rural areas as well as coastal and non-coastal regions. Accordingly, 1440 consumer household from urban coastal (Puri), rural coastal (Balasore) and non-coastal urban (Cuttack) and non-coastal rural (Mayurbhanj) districts were selected (Fig. 1) using a well-structured questionnaire post reconnaissance study. Purposive random sampling method was implied for selecting the study locales.

The schedule elicited data on each person's profile, income, spending, fish eating habits, top species preferences, top purchasing sources and factors influencing fish consumption. Statistical methods such as conjoint analysis and Garrett ranking were used to analyse the data. To ascertain consumer preferences and patterns of fish consumption among the respondents, conjoint analysis, discriminant analysis and preference evaluation index approaches, were used. The tools of analysis used for the study detailed below.

Conjoint analysis

In order to establish the significant levels of product attributes, the conjoint analysis employs two alternative calculating approaches. The first is determining the differences between each feature's partial utility values (part-worth values). In a partial utility model, each product feature level is independent of the others and the total utility of the consumer is comprised of partial advantages at each feature level. Partial utility determines a consumer's overall opinion of a product or service, and hence the contribution of each feature to his preference (part-worth). The commonly used part-worth contribution model (additive part-worth) in conjoint analysis can be explained as follows:

$Pref_{ijkl} = a_i + b_j + c_k + d_l$

where, $Pref_{ijk}$ = Consumer preference or overall usefulness

a_i = Product A feature part-worth in level i

b_j = Product B feature part-worth in level j

c_k = Product C feature part-worth in level k

d_l = Product D feature part-worth in level l is expressed so

Preference assessment index (PAI)

The demand for different types of fish increased as a result of this study's use of a composite preference assessment index (PAI) approach to evaluate the factors influencing customer preference. Using the set of indicators listed in the tables, we conducted a

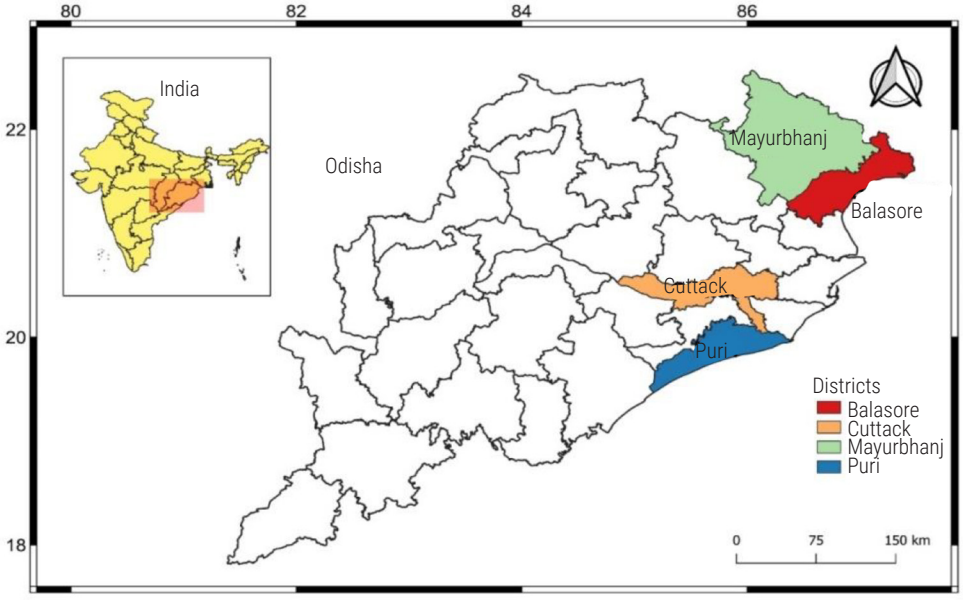

Fig. 1. Map of the the study locales

quantitative analysis of the preference index based on the systems using a combination of individual indicators. Because, each indicator was measured on a different scale, the following equations were used to normalise (rescale) them from 0 to 1.

$$x_{ij} = \frac{X_{ij} - \min_i \{X_{ij}\}}{\max_i \{X_{ij}\} - \min_i \{X_{ij}\}} \text{ ; if } x_{ij} \text{ increases with preference } \ldots\ldots\ldots\ldots(1)$$

$$y_{ij} = \frac{\max_i \{y_{ij}\} - y_{ij}}{\max_i \{y_{ij}\} - \min_i \{y_{ij}\}} \text{ ; if } y_{ij} \text{ decreases with preference } \ldots\ldots\ldots\ldots(2)$$

The effects on the preference indices are represented by the variables xij and yij. After being normalised, the data were transformed into a four-point Likert scale with score values of 0-0.25, 0.26-0.50, 0.6-0.75 and 0.76-1, with score values of 1 (low), 2 (moderate), 3 (high) and 4 (very high), respectively. To create a composite preference index, the mean values of the various species and the various preference factors were determined.

Discriminant analysis

Discriminant analysis was carried out using the following equation:

$D = v_1x_1 + v_2x_2 + v_3x_3, \ldots\ldots\ldots vixi + a$ *etc.*

where, D is for discriminate function, v for the discriminant coefficient of weight for that variable, x stands for respondent's score for that variable, a is constant, and i stands for the number of predictor variables.

Results and discussion

In the recent decades, there has been a clear shift from the grain consumption to fish consumption and to animal products consumption (Das, 2006). This decline is due to various reasons, including income growth and urbanisation and associated changes in life styles, changes in relative prices and the availability of non-grain food. This changes in food consumption pattern have been also observed across sectors (urban and rural) and income groups.

Demographic profile

Gender, age and educational background are among the socio-demographic characteristics of respondents. This study comprised a toal of 1440 respondents. The gender information of the respondents is shown in Table 1. The findings show that there are more male respondents (86.66%) than female respondents (13.34%t). In contrast, there were more than 87% male respondents available for the survey in coastal districts.

Age profile

The age profile of the respondents points outs that 25.07% of the respondents came under the age group of 20-29, followed by 56.88% of the respondents in 30-49 year age group and 18.05% under the more than 50 age group (Table 2).

Educational status

The interviewees' educational backgrounds reveal that the majority of them had college level education, with 20.56% of the respondents having completed elementary school, while 22.29% had completed high school. Only 6.74% of respondents had completed their higher education and 2.64% had a professional degree. Low levels of illiteracy (23.40%) in the sample suggest a high level of education (Table 3).

Household expenditure pattern

The average monthly expenditure of the respondents was studied and the results (Fig. 2) show that Coastal urban (₹21,592) has the highest average monthly house hold expenditure followed by non-coastal urban (₹14,434), non-coastal rural (₹12,980) and coastal rural (₹8,483).

The average monthly cost of food in coastal rural households is ₹4540, with a range between ₹2,510 and ₹6,570. The average monthly cost for fish is ₹900, with a range of ₹1,400 to ₹400. In contrast, respondents in non-coastal rural areas reported spending 40% of their income on food (Rajeev and Bhandarkar, 2022). In Non-coastal urban districts, the respondents on an average spend ₹7334 (51.16%) on food, followed by education (16.04%), shelter (11.24%), health care (6.54%),clothes (5.49%), fuel/electricity (4.02%) and social expenses (7.72%). In coastal urban area, the expenditure is high on food (61.79%) followed by healthcare (10.73%),education (9.14%), clothes (6.43%), fuel/electricity (5.14%), shelter (4.02%) and social expenses (2.75%).

Fish consumption profile

The findings of analysis of the frequency of fish eating throughout the chosen regions (Table 4), indicated that 34.71% of the respondents consume fish twice in a week followed by 32.36% consuming fish on alternate days, 20.49% daily and 5.42% weekly. Comparing the area-wise fish consumption, coastal rural areas consume alternatively (58.22%), non-coastal urban (52.70%) and coastal urban consume twice in a week (52.77%) and non-coastal rural consume daily (75.33%). Similar to our findings, Jena and Mahapatra (2023) reported high consumption of cereals and fish by fishing group of Odisha coast. The consumption of pulses, oil and sugar was low, whereas that of vegetable, meat and egg was negligible.

Table 1. Gender details of the respondents in Odisha

Gender	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
Male	360(100)	258(71.62)	360(100)	270(75)	1248(86.66)
Female	0	102(28.33)	0	90(25)	192(13.34)
Total	360(100)	360(100)	360(100)	360(100)	1440(100)

Figures in parenthesis indicate percent to total

Table 2. Age of the selected respondents in Odisha

Age (years)	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
20-29	83(23)	90(25.02)	72(20.1)	116(32.22)	361(25.07)
30-39	105(29.2)	81(22.51)	102(28.2)	113(31.39)	401(27.85)
40-49	109(30.2)	128(35.63)	116(32.14)	65(18.06)	418(29.03)
>50	63(17.6)	61(16.84)	70(19.56)	66(18.33)	260(18.05)
Total	360(100)	360(100)	360(100)	360(100)	1440(100)

Figures in parenthesis indicate percent to total

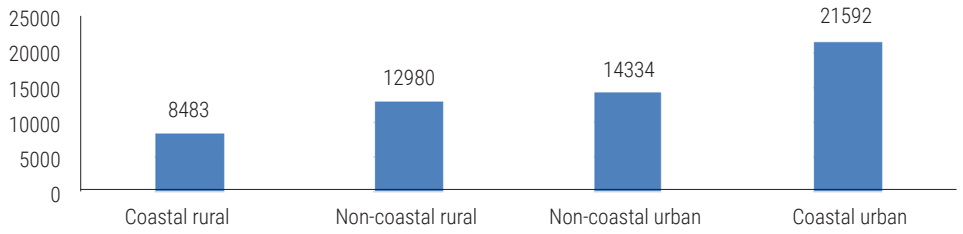

Fig. 2. Average monthly expenditure in different regions of Odisha

Table 3. Education details of the selected respondents in Odisha

Education level	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
Illiterate	30(8.24)	37(10.24)	160(44.32)	110(30.56)	337(23.40)
Primary	63(17.40)	63(17.40)	75(20.89)	95(26.37)	296(20.56)
High School	75(20.89)	82(22.65)	63(17.40)	101(28.06)	321(22.29)
Higher Secondary	23(6.65)	25(16.89)	30(8.24)	19(5.28)	97(6.74)
Collegiate	160(44.32)	144(40.32)	23(6.65)	24(6.67)	351(24.37)
Professional	9(2.50)	9(2.50)	9(2.50)	11(3.06)	38(2.64)
Total	360(100)	360(100)	360(100)	360(100)	1440(100)

Figures in parenthesis indicate percent to total

The average annual *per capita* fish consumption was found to be 15.25 kg across all study locations, ranging from 6.36 kg in rural non-coastal regions to 23.98 kg in urban coastal regions.

It was observed that the yearly *per capita* consumption in non-coastal metropolitan areas and coastal rural areas was 15.31 and 18.94 kg, respectively (Tables 5, 6). The analysis of the average species composition in the monthly *per capita* fish consumption basket revealed that Barracuda (0.2 kg) is the most consumed species in the study locations. The increase in consumption has been driven not only by the increase in production but also by a combination of many factors such as technological developments in fish processing, cold chain, shipping and distribution (Delgado *et al.*, 2003), rising incomes of people in the state, which strongly correlate with increased demand for fish and fishery products; reduction in loss and waste and increased awareness of the health benefits of fish among consumers (Kumari, 2014).

Access to buying fish

The results of access to buying fish (Table 7) indicates that 97% of the respondents travel less than 1 km and 3% travel 1 to 2 km to buy fish. The results reveal that majority of the respondents were in close access to fish buying source (Dandage *et al.*, 2017).

Table 4. Frequency of fish consumption in the selected study regions of Odisha

Frequency	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
Daily	4(1.11)	4(1.11)	271(75.33)	16(4.40)	295(20.49)
Alternate days	210(58.22)	140(38.89)	81(22.42)	35(9.72)	466(32.36)
Twice in a week	120(33.45)	190(52.70)	0	190(52.77)	500(34.71)
Weekly	26(7.22)	26(7.22)	0	26(7.22)	78(5.42)
Fortnightly	0	0	8(2.25)	2(0.56)	10(0.70)
Seasonal	0	0	0	17(4.77)	17(1.18)
Monthly	0	0	0	74(5.14)	74(5.14)
Total	360(100)	360(100)	360(100)	1440(100)	1440(100)

Figures in parenthesis indicate percent to total

Source of purchase

There are numerous sources of purchases among the different consumers (Table 8). Among the participants, the main source of purchase are the way side markets (32.63%) followed by retail markets (29.86%). Sajeev *et al.* (2021) reported that the major source of fish purchase differed with locations. In non-coastal urban (45%) and non-coastal rural (50%) area, the main source of purchase is the retail market. Coastal rural (50%) and coastal urban (55.55%) areas have way side markets as the major source of purchase.

Conjoint analysis

Conjoint analysis is the process through which a consumer or decision-maker systematically assesses and estimates a small number of options. (Halbrendt *et al.*, 1991; Vriens *et al.*, 1998). Three basic processes make up much of conjoint analysis. Determining the appropriate product feature set that offers consumer the most utility comes first. The second step is figuring out how closely related different product combinations are to one another. Third step involves the profitability assessments, marketing margin and usage. Conjoint analysis begins with the total utility hypothesis, which states that total utility is a function of price utility and quality utility. In this study conjoint analysis was used to identify customer preferences using 3 components and 24 different factor levels, resulting in 324 unique combinations. The options were drastically reduced to 25, which seems feasible for further study, using the fractional factorial design.

The findings of the study suggest that sources of purchasing fish is the most significant factor in determining the consumer's choice of fish consumption,. About 36.57% of purchasing decisions were influenced by the sources from which seafood was purchased. The drivers for purchasing fish were the second most significant

Table 5. Average monthly fish consumption in the study regions of Odisha (kg)

Monthly	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
< 1 kg	112(31.11)	357(99.1)	122(33.89)	283(78.55)	874(60.70)
1-2 kg	86(23.88)	3(0.9)	85(23.61)	74(20.54)	248(17.22)
2-3 kg	160(44.44)	0	150(41.67)	3(0.91)	313(21.74)
3-5 kg	0	0	0	0	0
>5 kg	2(0.57)	0	3(0.183)	0	5(0.34)
Total	360(100)	360(100)	360(100)	360(100)	1440(100)

Figures in parenthesis indicate percent to total

Table 6. Average species composition (kg) in monthly *per capita* fish consumption basket

Species	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
Anchovies	0	0	0	0.051	0.013
Barracuda	0.200	0.200	0.200	0.198	0.200
Bombay duck	0	0	0	0.094	0.024
Carps	0.125	0.236	0	0.155	0.129
Cat fish	0	0.094	0	0.143	0.059
Cephalopods	0.094	0	0	0.090	0.046
Flat fish	0	0.161	0	0.077	0.060
Hilsa	0.161	0	0	0.096	0.064
Mackerel	0.100	0	0.100	0.124	0.081
Pomfrets	0.100	0	0	0.059	0.040
Rays	0	0	0	0.183	0.046
Red snapper	0	0	0	0	0.000
Ribbon fishes	0.100	0	0.100	0.106	0.077
Sardine	0.230	0.117	0.130	0.096	0.143
Seer fish	0	0	0	0.097	0.024
Shark	0	0	0	0.105	0.026
Shrimps	0	0	0	0.064	0.016
Threadfin breams	0	0	0	0	0.000
Tuna	0	0	0	0.084	0.021
Others	0.468	0.468	0	0.175	0.278
Total	1.578	1.276	0.230	1.998	1.271

Table 7. Distance travelled for purchase of fish in the study locales in Odisha

Distance	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
< 1 km	357(99.1)	357(99.1)	324(90)	357(99.1)	1395(97)
1 to 2 km	3(0.9)	3(0.9)	36(10)	3(0.9)	45(3)
2 to 5 km	0	0	0	0	0
> 5 km	0	0	0	0	0
Total	360(100)	360(100)	360(100)	360(100)	1440(100)

Figures in parenthesis indicate percent to total

component, with a significance of 32.44%. The rationale for the sources of purchase place is the third factor influencing consumption patterns. The relevance of the place of purchase on consumer choice is roughly 30.99% (Table 9).

Every factor level's part-worth or marginal utility value demonstrates how it affects consumer choices. Consumers like the option with the highest part-worth, which is the factor level (Boughanmi, 2007). The biggest part of the drivers for purchasing fish, which is the most important component, has the highest value for tradition (0.55), followed by flavour and preference and meat substitute (0.51). The utility value of the quality is 0.34, compared to 0.40 for the variety of species. Persuasion comes in at roughly 0.32-part worth value after availability with a 0.33-part worth score. The least important factors when choosing to purchase fish are nutrition and price/affordability, with part worth values of roughly 0.25 and 0.13, respectively. As a result, the majority of people purchase fish as an alternative to meat due to its taste and preference.

Table 9. Conjoint analysis

Factors	Part worth value	Significance level (%)
Drivers for buying fish		
Price/Affordability	0.13	32.44
Quality	0.34	
Nutrition	0.25	
Species	0.40	
Taste and preference	0.51	
Substitute to meat	0.51	
Persuasion	0.32	
Tradition	0.55	
Availability	0.33	
Accessibility	0.30	
Sources of purchasing fish (SOP)		
Landing centre	0.16	36.57
Retail market	0.50	
Wholesale market	0.31	
Online	0.05	
Fish vendors at door step	0.43	
Supermarkets	0.12	
Way side market	0.33	
Reasons for source of purchase place (RSP)		
Distance	0.43	30.99
Freshness	0.45	
Variety of species	0.23	
Credit	0.19	
Cheap	0.30	
Trust	0.21	
Time	0.15	
Total worth constant	5.24	
Total (%)		100.00
Pearson's R = 0.998	Significance = 0.0000	
Kendall's Tau =0.833	Significance = 0.0009	

Table 8. Source of fish purchase in the study locales in Odisha (No. of respondents)

Source of purchase	Coastal Rural	Non-Coastal Urban	Non-Coastal Rural	Coastal Urban	Total
Landing / Production centre	54(15)	76(21)	36(10)	91(25.28)	257(17.85)
Retail market	43(12)	162(45)	180(50)	45(12.50)	430(29.86)
Fish vendors at door step	18(5)	36(10)	18(5)	2(0.56)	74(5.14)
Wholesale market	47(13)	43(12)	36(10)	21(5.83)	147(10.21)
Online	0	0	0	0	0
Super market	18(5)	25(7)	18(5)	1(0.28)	62(4.31)
Way side market	180(50)	18(5)	72(20)	200(55.55)	470(32.63)
Total	360(100)	360(100)	360(100)	360(100)	1440(100)

Figures in parenthesis indicate percent to total

The greatest part-worth score for the retail market (0.50), which is the second-most significant element in consumption choice, is followed by the fish vendors at the door (0.43). With a component worth score of roughly 0.33 for the wayside market and roughly 0.31 for the wholesale market, people apparently preferred to purchase their fish there. Consumer preference for the sources of purchasing fish gives the landing center a 0.16-part worth score compared to the mega market's 0.12-part worth score. The findings show that most customers, independent of other sources, chose to buy fish from retail marketplaces. The consumers' choice of a certain store to make their purchase may be influenced by criteria such as quality, good taste, and affordability. The findings also show that consumers choose where to buy fish for consumption based on fish vendors at doorstep and wayside markets, as well as the landing centre and supermarkets.

The freshness of the fish that is accessible at the purchasing location took first place with the highest part worth value of roughly 0.45, making it the third and final significant element in consumer preference. With a component value of 0.43, the distance to the buying location is the second most important factor. With part worth ratings of approximately 0.30 and 0.23, respectively, the affordable price and variety of species continue to rank second in terms of consumer desire. Trust between fish suppliers and customers accounts for 0.21 of the value of the consumer choice. However, credit makes around 0.19 of the part of the score. Time has the lowest part worth score of all the factors, which is around 0.15, indicating that it has little bearing on the reasons people buy fish.

The impact of considering factors on customer preferences is represented in conjoint analysis by the difference between factor levels as well as the part-worth of each factor level. When the data are evaluated, it is found that there is a significant difference between the part-worth values in the motivations and preferences for purchasing fish (Hadi *et al.,* 2013). In light of this, it can be said that buyers tend to purchase the fish varieties that offer the most value.

The sum of the factor level scores determines the average and total utility or worth values of the combinations that were designed within the parameters of the conjoint analysis. The product feature set that gives customers the most utility is referred to as the combination with the highest overall worth. Consumers receive the barest amount of advantage from the feature package with the lowest total worth value. In other words, customers give preference to the element and factor level with the highest overall utility. The product set that consumer favour least is the one with the lowest overall utility value. Based on these overall findings, it can be concluded that the variety of fish from fish markets, which are extremely healthy, good quality, and tasty, is the fish quality set that offers the consumers the maximum advantage (Table 10).

Preferred species and the main factors influencing fish consumption

The preference index is a composite indicator that considers a number of factors that affect fish consumption, including accessibility, quality, nutrition, tradition and availability (Shyam *et al*., 2021). Table 11 provides the respondents' preference index for the various fish species.

Driving forces of fish consumption: Discriminant analysis

Consumer preferences and satisfaction can be evaluated in order to pinpoint the driving forces behind rising consumer demand for different types of fish. Consumer preferences vary widely among consumers (Shyam *et al.*, 2019, 2023). The discriminant analysis method finds many motivators for fish eating by analysing the respondents' choices for consumption (Table 12).

The significance of the function was evaluated using the Wilks' lambda statistic. Indicating that the model is important and explains why consumers prefer to consume fish, Wilks' lambda's value of 0.147, which translates to a chi-square of 18.307 with 9 degrees of freedom, (p 0.000), shows that the model is significant.

The discriminant analysis table shows that quality, which has the highest Wilks' Lambda of 0.918 and highest canonical loading (0.814 or 81.4%), is the most significant discriminant factor. It is followed by nutrition (0.678 or 67.8%), availability (0.533 or 53.3%), accessibility (0.458 or 45.8%), taste and preference (0.454 or 45.4%), price (0.38 or 38%), and persuasion (0.454 or 45.4 %) (-0.20 or 20%). Prabhakar *et al.* (2020) reported that price and persuasion have very little influence on respondents' fish eating. Fig. 3 clearly identifies the various justifications for fish eating as discriminating criteria.

Constraints in fish consumption

The Table 13 provides the Garrette rating for the restrictions on fish consumption. The second biggest problem in the research areas is a scarcity of fresh seafood. Devi *et al.* (2023) stated that the main barrier to fish eating was the absence of favoured fish species. According to the respondents, despite the high prices, fish demand and purchase have not yet decreased for these reasons and fish consumption has only increased moderately. However, erratic availability, large price swings and other factors play a significant effect in how consumers choose to consume. They are forced to rely on fish products and other sources in order to consume fish. The results might easily be interpreted to mean that people now eat fish as a staple diet.

The study results indicate that the fish consumption in Odisha is on the rise. According to the consumption analysis, the average annual *per capita* fish intake across the study locations was 15.25 kg. Rural non-coastal areas had the lowest average consumption at 6.36 kg, while urban coastal areas recorded the highest at 23.98 kg. The annual *per capita* consumption in non-coastal urban areas and coastal rural areas was 15.31 and 18.94 kg, respectively. Despite the high fish prices, the study identified that the fish consumption across the state has increased, with majority of the respondents consuming fish on a regular basis. The survey also emphasises

Table 10. Optimum fish quality set

Drivers of buying fish	Quality	Total Worth Utility
Source of purchase	Retail market	1.731
Reasons for the place of purchase	Freshness	

Table 11. Preference index of major fish species in Odisha

Species	Parameters									Preference index
	Availability	Accessibility	Quality	Nutrition	Taste and Preference	Tradition	Meat Substitute	Persuasion	Price	
Catla	0.59	0.82	0.41	0.56	0.62	0.68	0.54	0.4	0.69	0.59
Rohu	0.77	0.71	0.48	0.84	0.79	0.76	0.41	0.2	0.23	0.58
Carps	0.72	0.7	0.55	0.62	0.65	0.72	0.35	0.39	0.3	0.56
Shrimps	0.78	0.71	0.43	0.63	0.54	0.85	0.33	0.19	0.59	0.56
Sand whitings	0.72	0.7	0.55	0.62	0.65	0.72	0.35	0.39	0.3	0.56
Croakers	0.83	0.77	0.65	0.63	0.62	0.48	0.5	0.17	0.3	0.55
Hilsa	0.81	0.55	0.65	0.63	0.52	0.58	0.64	0.27	0.3	0.55
Mackerel	0.64	0.57	0.38	0.4	0.62	0.68	0.54	0.4	0.69	0.55
Pomfret	0.56	0.71	0.52	0.6	0.61	0.5	0.51	0.41	0.43	0.54
Catfish	0.72	0.62	0.61	0.69	0.77	0.53	0.54	0.24	0.27	0.54
Mullet	0.74	0.7	0.53	0.69	0.7	0.57	0.47	0.18	0.28	0.54
Opisthopterus tardoore	0.59	0.63	0.52	0.48	0.62	0.61	0.39	0.38	0.51	0.53
Crab	0.7	0.79	0.64	0.57	0.38	0.4	0.35	0.12	0.64	0.51
Cirrhinus reba	0.64	0.63	0.52	0.62	0.53	0.59	0.4	0.23	0.45	0.51
Mola sp.	0.7	0.79	0.64	0.57	0.38	0.4	0.35	0.12	0.64	0.51
Puntius sp.	0.44	0.77	0.65	0.63	0.62	0.48	0.5	0.17	0.3	0.51
Tilapia	0.67	0.59	0.5	0.53	0.57	0.52	0.27	0.47	0.31	0.49
Ribbon fish	0.69	0.69	0.61	0.57	0.44	0.4	0.32	0.15	0.48	0.48
Perch	0.71	0.61	0.57	0.48	0.54	0.42	0.43	0.2	0.36	0.48
Sardines	0.52	0.45	0.7	0.47	0.56	0.39	0.53	0.3	0.35	0.47
Flatfish	0.43	0.72	0.64	0.46	0.49	0.31	0.34	0.15	0.49	0.45
Tuna	0.57	0.38	0.65	0.27	0.48	0.48	0.59	0.22	0.3	0.44
Bombay duck	0.55	0.65	0.63	0.62	0.18	0.4	0.13	0.12	0.64	0.44

Table 12. Discriminant analysis

Parameters	Wilk's lambda	Significance
Availability	0.873	0.001
Accessibility	0.732	0.000
Quality	0.918	0.033
Nutrition	0.907	0.025
Taste and preference	0.625	0.000
Tradition	0.335	0.000
Meat substitute	0.244	0.000
Persuasion	0.455	0.000
Price	0.534	0.000
Others	0.211	0.000
	Structural matrix (Canonical loadings)	Unstandardised canonical discriminant function coefficient
Availability	0.533	2.32
Accessibility	0.458	1.32
Quality	0.814	0.88
Nutrition	0.678	0.63
Taste and preference	0.454	0.25
Tradition	-0.200	0.35
Meat substitute	-0.169	0.11
Persuasion	0.255	0.89
Price	0.380	1.00
Others	-0.124	-0.10
Constant		-3.63
Canonical correlation 0.88; Wilks's lambda (λ) 0.147; Chi square (9 df) (18.307) (p<0.000)		

that the retail market, followed by wayside markets, are the primary source of purchase. The most significant barrier to fish consumption is the shortage of preferred fresh fish. Other constraints include high price, price volatility, irregular supply and unhygienic buying sources, which reflects certain structural issues in the fishing business. To ensure availability of fish at fair prices, it is recommended that local fisherman be educated on the importance of adhering to acceptable handling practices. Additionally, appropriate policies and procedures need to be established to raise consumption levels and improve sanitation standards across the fish supply chain.

Acknowledgements

The article is based on an ICAR-CMFRI, Kochi-funded project titled "Marine fish distribution and consumption demand in India: A policy outlook. We sincerely thank the Director, ICAR-CMFRI, Kochi for providing the funding necessary to carry out this work. We also thank the respondents from the districts of Puri, Balasore, Cuttack and Mayurbhanj for contributing their insightful information on the fish consumption survey.

References

Boughanmi, H. 2007. Estimating consumer preferences for value-added fish products in Oman: A conjoint analysis. *J. Food Products Marketing*, 13(2): 47-68. https://doi.org/10.1300/J038v13n02_04.

Das, M. K. 2006. Fish health management. In: *Handbook of fisheries and aquaculture*, 1st edn. Indian Council of Agriculture Research, New Delhi, India, pp. 411-537.

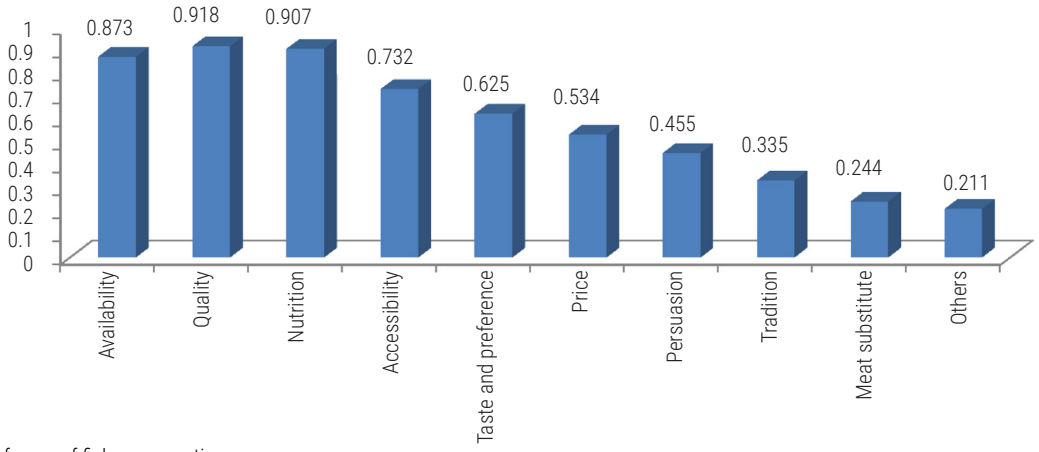

Fig. 3. Driving forces of fish consumption

Table 13. Constraints in increasing fish consumption

	Coastal Rural		Non-Coastal Urban		Non-Coastal Rural		Coastal Urban		Total	
Attributes	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
Irregular supply	43	IV	19.81	X	85.01	I	48	IV	48.96	III
Lack of fresh fish	40	V	43.28	VII	72.32	II	42	V	49.40	II
Wide fluctuations in price	44	III	45.69	VI	40.10	V	49	III	44.70	IV
High price	55	I	22.58	IX	27.9	VIII	50	II	38.87	VII
Poor access to buying	35	VI	30.25	VIII	36.78	VI	39	VI	35.26	VIII
Lack of hygiene in purchase sources	31	VII	52.35	IV	45.67	IV	38	VII	41.76	V
Unavailability of preferred fishes	50	II	75.20	II	66.54	III	54	I	61.44	I
Restricted to social function	22	VIII	81.63	I	32.33	VII	29	VIII	41.24	VI
Tradition	18	IX	63.44	III	15.65	X	26	IX	30.77	IX
Lack of awareness	12	X	52.13	V	26.51	IX	15	X	26.41	X

Devi, B. N., Sahu,A., Nirmalkar, D., Paikra, C. and Sahu, R. 2023. Exploring fish consumption patterns: A comparative study of urban and rural households in Kawardha (Kabirdham District), Chhattisgarh, India. *Asian Journal of Agricultural Extension, Economics and Sociology,* 41(10): 83-91. https://doi.org/10.9734/ajaees/2023/v41i102145.

Delgado, C. L., Wada, N,, Rosegrant, M. W., Meijer, S. and Ahmed, M. 2003. *Fish to 2020: Supply and demand in changing global markets, WorldFish Center Technical Report 62.* International Food Policy Research Institute Washington, D.C., USA and WorldFish Center, Penang, Malaysia, 226 p.

Dandage, K., Badia-Melis, R. and Ruiz-García, L. 2017. Indian perspective in food traceability: A review. *Food Control*, 71: 217-227. https://doi.org/10.1016/j.foodcont.2016.07.005.

FAO, IFAD, WFP 2013. *The state of food insecurity in the World 2013-The multiple dimensions of food security*. Food and Agriculture Organisation of the United Nations, Rome, Italy.

Hadi, A. H. I. A., Selamat, J., Shamsudin, M. N. and Radam, A. 2013. Eliciting Malaysian consumer preferences for marine fish attributes by using conjoint analysis. *World Applied Sciences Journal,* 28(12): 2054-2060.

Halbrendt, C. K., Writh, F. F. and Vaughn, G. F. 1991. Conjoint analysis of the mid-Atlantic food fish market for farm raised hybrid striped bass. *South. J. Agric. Econ.,* 23(1): 155-164. https://doi.org/10.1017/S0081305200017933.

Jena, D. and Mahapatra, B. 2023. Exploring the effects of energy consumption on millets and rice yields in Oisha, India, *Energy Nexus*, 12: 100253. https://doi.org/10.1016/j.nexus.2023.100253.

Kumari, M. K. and Patra, S. 2014. Growth and performance of fishery in Odisha. *Asian J. Res. Business Econ. Manage.,* 4(6): 100-110.

Mohanty, B. P. 2011. Fish as health food. In: *Handbook of fisheries and aquaculture,* 2nd edn. Indian Council of Agriculture Research, New Delhi, India, pp. 843-861.

Prabhakar, P. K., Vasta, S., Srivastav, P. P. and Pathak, S. S. 2020. A comprehensive review on freshness of fish and assessment: Analytical methods and recent innovations. Food Res. Int., 133: 109157.

Rajeev, M. and Bhandarkar, S. 2022. *Unravelling supply chain networks of fisheries in India: The transformation of retail*. Springer Nature. Singapore, 132 p.

Sajeev, M. V., Joshy, C. G., Rejula, K., Sajesh, V. K., Suresh, A., Mohanty, A. K. and Ravishankar, C. N. 2021. Drivers and barriers to online fish purchase in Kerala, India. *Fishery Tech.,* 58(4): 246-256.

Shyam, S. S. 2013a. Demand and supply paradigms for fish food security in India. *Seafood. Exp. J.*, 43(5): 34-40.

Shyam, S. S. 2013b. Demand pattern and willingness to pay for high value fishes in India. *J. Mar Biol. Ass. India*, 55(2): 48-54. https://doi.org/10.6024/jmbai.2013.55.2.01764-08

Shyam, S. S. 2016. Fish consumption pattern in India, exports - Overview. *Food and Beverage News*, August 1-15, 2016, pp. 25-28.

Shyam, S. S., Athira, N. R., Athira, P. R., Safeena, P. K.. Ramees, R. M., Reeja, F. Remya, R. and Smitha, R. X. 2019. Assessing demand drivers in augmenting fish consumption in Ernakulum. *Indian J. Econ. Dev.*, 7(5): 1-8.

Shyam, S. S., Raju, S. S., Athira, N. R. and Pattnaik, P. 2021. Assessing fish consumption and its determinants across Andhra Pradesh, India. *J. Mar Biol. Ass. India*, 63(2): 21-30.

Shyam, S. S., Shinu, A. M., Athira, N. R., Vase, V. K.,Kumaran, A., Bhatt, B. and Rebello, S. 2023. Spatial fish consumption paradigms and perceptions across Gujarat State. *Medicon Agric. Environ. Sci*., 6(3): 26-37.

Vriens, M., Looschilder, G., Rosbergen, E. and Wittink, D. R. 1998. Verbal *vs.* realistic pictorial representations in conjoint analysis with design attributes. *J. Prod. Innov. Manage*., 15: 445-467.