

Consumer Preference for the Ready-to-eat Fish and Shrimp Balachao: A Potential Value-added Fishery Product for Bangladesh

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Abstract Fish and shrimp-based value-added products of Bangladesh have great potential in the food markets. A panel test was conducted on ready-to-eat shrimp and fish products, called the Balachao, with 60 respondents of different ages and genders to evaluate consumer preference. Twenty participants were chosen from each of the three age classes: less than 20, 20-40, and above 40 years, with a 1:1 ratio for males and females. Three groups of products were prepared: dried shrimp (A), Bombay duck fish (B), and ribbon fish (C). Each product group had three unique recipe codes with different dried fish and shrimp percentages. The proximate composition was analyzed to determine the nutritional value of the products. Participants' feedback on external appearance, taste, odor, juiciness, crispness, price and overall acceptability was collected through a questionnaire, categorized, and statistically analyzed. Recipes A2 (50% shrimp), B2 (50% Bombay duck), and C2 (50% ribbon fish) obtained the highest mean scores for each evaluation criterion, and they were significantly different from the other recipes ($p < 0.05$). In addition, the highest percentage of participants from different age classes and genders preferred these recipes. No significant correlation was found between overall acceptability and participants' sex and age class ($p > 0.05$). The study revealed that recipes A2, B2, and C2 had good acceptability to consumers and could be potential value-added fishery products in Bangladesh. The findings of this study will contribute to the field of consumer behavior and market potential for value-added fishery products.

Keywords: Balachao, fishery product, value addition, dry fish, sensory evaluation, panel test

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1. Introduction

Bangladesh is globally recognized for its enriched fisheries resources and ranks third in the world in inland fisheries production [1,2,3]. Fish contributes to food and nutritional security in Bangladesh by accounting for 3.52% of the Gross Domestic Product (GDP), 26.37% of the Agricultural GDP, 1.39% of total export profits, and more than 12% of employment. It is currently turning into a self-sufficient fish-producing nation that meets approximately 60% of its population's daily animal protein requirements, with a per capita intake of 62.58 g/day compared with the provision of 60 g/day [4]. Consumer demand for value-added fish products is increasing along with the rising trend in fish production in Bangladesh. The

best strategy to increase the demand for fishery products and ensure their proper usage of fishery products in Bangladesh is to produce quality-based value-added fish products [5,6,7].

Globally, fish and shrimp are in high demand because they contain high-quality proteins, essential vitamins, and crucial polyunsaturated fatty acids [8,9]. Unselective fishing methods produce significant shrimp by-products, which result in the disposal of tiny fish and shrimp, leaving underutilized resources [9,10,11]. These underutilized fish and shrimp species can potentially provide sources of high-quality proteins and other nutrients [12]. The need to increase the use of underutilized fish as value-added fishery products for human consumption has received considerable attention worldwide [13].

A procedure that alters the qualities of primary materials to add value to a product or service is known as

adding value, and the result is known as a value-added product [14]. The fish processing industry now emphasizes quality assurance and value addition to improve profitability. Value-added products in the fish processing industry have created opportunities for foreign exchange [15]. Currently, different types of value-added products are available in Bangladesh, including mince- or surimi-based fish products, ready-to-eat, and ready-to-cook fish products, among which ready-to-eat products such as fish fingers, cutlets, patties, burgers, sausages, and fish balls are more popular to the people [16].

Food preference tests and measurements are extrinsic indicators of food quality, management systems, and acceptability in the market chain [17,18]. Some tactics, such as cues, allow customers to gain information and make judgments regarding food quality. Sensory evaluation of fish products is the traditional and most commonly used method for assessing food quality [19]. Moreover, understanding food products' quality is somehow dependable on the consumer preference test [20]. Preference tests help consumers understand food quality by evaluating its quality attributes [21].

Customer perception survey is a common way to determine how customers differ from one another in terms of their potential product preferences [22,23]. Recently, a trained panel test on food quality was used to better understand consumer perceptions and preferences, allowing for the development of efficient marketing strategies for the food industry [24]. In recent years, consumer preferences have significantly increased for ready-to-eat (RTE) products owing to rapid urbanization, lack of time for cooking [25], and the increased purchasing capacity of consumers [26]. Students, young people, and working people now prefer ready-to-eat foods to save time and energy [25].

Balachao is a popular value-added fishery product among the people of the Chattogram and Cox's Bazar regions of Bangladesh. It is a dried and spicy pickle; made from shrimp, fish, fried onions, garlic, ginger, and red chilies traditionally. There is no documented ingredient composition and preparation procedure for Balachao. Consumers can have it directly or use it as an additive to improve the taste of regular local dishes, such as fried rice, mixed dal, khichuri, noodles, and vegetables. Unfortunately, only a few value-added fish products are commercially produced in Bangladesh.

In Bangladesh, there is a limited attempt to conduct consumer preference tests of value-added products because of a lack of entrepreneurship, unavailability of quality products, and variability in consumer behavior [27]. Bangladesh has the potential as well as the limitations to grow its fish and seafood export market. Public and private standards must play a role in ensuring the safety and quality of exportable fish products [28]. It is necessary to assess the consumer acceptance of fish and seafood products to standardize them for national and international markets. Therefore, the present study aimed to investigate the consumer acceptance of three value-added fish and shrimp Balachao and derive the influence of age and sex on consumer preferences for these products. The study adds to the body of knowledge regarding consumer expectations for value-added fishery products, and the findings offer the practical potential of standard

recipes of Balachao for food market applications. The findings will be particularly helpful for businesses existing on or wanting to enter the Balachao market, and make contributions to the subject of consumer behavior.

2. Materials and Methods

2.1. Preparation of the Products

Three groups of ready-to-eat Balachao products were prepared using dried fish and shrimp as raw materials. The dried raw materials were shrimps of different species, dried Bombay duck (*Harpadon nehereus*), and dried ribbon fish (*Trichiurus haumela*), denoted as A, B, and C, respectively. Each of the products (A, B and C) had three unique recipes with different percentages of dried shrimp, fish, and spice ingredients. The detailed ingredients list of the recipes is given in Table 1. The dried raw materials of shrimp and fish were collected from Shah Amanat Traders, located at Cox's Bazar, Bangladesh. The collected raw materials were inspected for quality before collection and further processing. The supplier of the raw materials (dried shrimp and fish) was laboratory certified and used to follow a hygienic procedure, mechanical drying method, and vacuum packing system. The preparation procedure for the ready-to-eat Balachao includes several steps. First, the dried shrimps and fishes were chopped into small pieces. Second, the pieces were fried with oil and then cooled in large containers. Third, the fried pieces were mixed with fried sprained onion, garlic, and red chili flakes according to the recipe codes. Finally, the products were taken in airtight aluminum pots and sealed properly to avoid contamination. All ethical guidelines regarding animal welfare and standard laboratory protocols were strictly followed at each step of the whole process.

2.2. Proximate Composition Analysis of the Products

The proximate composition of the recipes was conducted at the Fish Processing Laboratory, Chattogram Veterinary and Animal Sciences University (CVASU). Crude protein, crude fiber, crude fat, ash, and minerals (Calcium and Phosphorous) content were analyzed using the standard methods of the Association of Official Analytical Chemists (AOAC) [29].

Table 1. The recipe group, code, and others ingredient percentages for the 100 g of dried fish and shrimp products were prepared for its consumer preference test

Recipe Group	Recipe Code	Dried fish or shrimp (%)	Other ingredients (onion, garlic and red chili flakes) (%)
A (Shrimp)	A1	40%	60%
	A2	50%	50%
	A3	60%	40%
B (Bombay duck fish)	B1	40%	60%
	B2	50%	50%
	B3	60%	40%
C (Ribbon fish)	C1	40%	60%
	C2	50%	50%
	C3	60%	40%

2.3. Preparation of the Questionnaire and Selection of the Criteria for Product Evaluation

A pre-constructed questionnaire in both English and Bengali was used to collect data from participants. Each questionnaire contained a unique identification number (ID), recipe code, participants' consent for the test, and criteria for product evaluation. The product evaluation criteria were external appearance, taste, odor, juiciness, crispness, price, and overall acceptability. Each criterion was assigned a five-point Likert scale: 5 = strongly acceptable, 4 = moderately acceptable, 3 = acceptable, 2 = less acceptable, and 1 = not acceptable.

2.4. Selection and Training of the Participants

The selection criteria for the participants were age, class, gender, and area to ensure diversity of the participants, precision of the panel test results, and

avoidance of bias. A total of 60 participants were selected from 29 districts and eight (8) divisions of Bangladesh (Figure 1). The male-female ratio was 1:1, and each of the three age classes (below 20, 20 to 40, and above 40 years) had 20 participants for the test. The selected participants were trained in the product evaluation process, scale and scoring system, questionnaire fill-up process, and overall guidelines prior to the panel test.

2.5. Distribution of the Products and Performing the Test

Each participant received a questionnaire and nine packets of products (three recipes from each category: A, B, and C) for evaluation. The packets were properly sealed and designated using a recipe code. The participants were given three consecutive days to taste one product group (A, B and C) with three recipes per day. They were properly instructed and trained to observe the product attributes and record their response to the questionnaire.

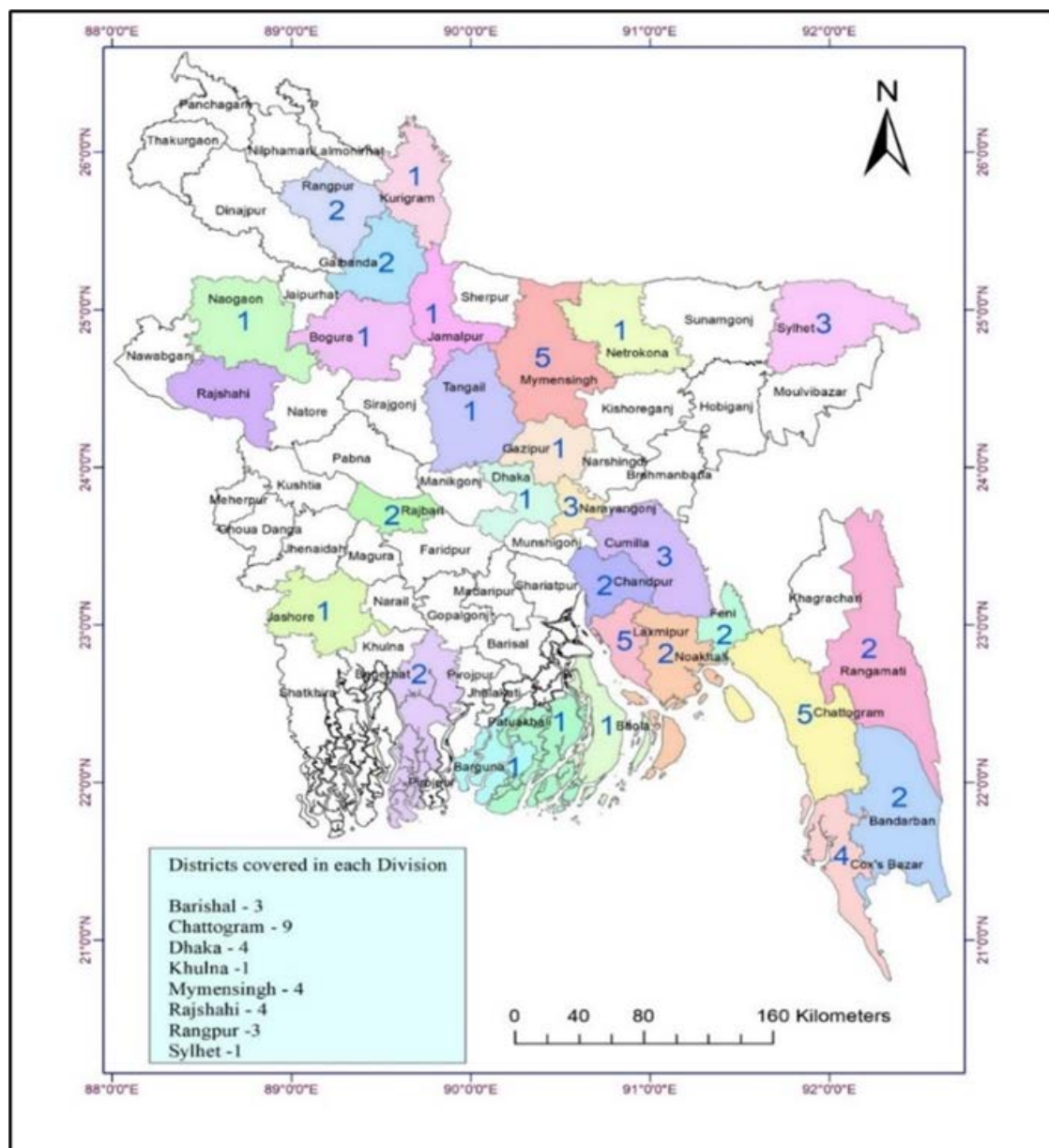


Figure 1. Demographic mapping of the selected participants for the test included participants from 29 districts and eight divisions of Bangladesh

2.6. Data Collection and Statistical Analysis

The questionnaires with participants' feedback were collected, and product evaluation data were recorded, categorized, and analyzed using Microsoft Excel (Version 2019) and the Statistical Package for Social Science (SPSS) (Version 24). The collected data were evaluated based on each criterion's average mean score on a Likert scale and expressed as mean $\pm$ standard deviation (SD). Likert scale (1-5) responses of the participants were statistically analyzed to evaluate the participants' preferences for the formulated recipes. The Kruskal-Wallis's test was used to identify the variability of participants' responses on the recipes of each product group (A, B, and C) with 95% confidence interval ($p < 0.05$). Spearman's correlation was conducted between 'overall acceptability and gender' and 'overall acceptability and age classes' to determine the influence of age and sex on product preferences ($p < 0.05$).

3. Results

3.1. Proximate Composition and Bacteriological Analysis

Table 2 presents the nutritional parameter percentages of the formulated recipes, including moisture (M), crude protein (CP), crude fiber (CF), crude fat (EE), Ash, calcium (Ca), and phosphorus (P). Recipe B1 had the highest percentage of M (6.91%), CF (8.08%), and EE (46.88%). The highest percentage of CP (41.65%) and ash (10.41%) content was found in recipe A3, whereas recipe B3 had the highest Ca (1.5%) and P (0.50%) content. Among the recipe groups (A, B, and C), the highest CP values were found in recipe groups A3, B3, and C3, the highest CF and EE values were found in A1, B1, and C1. The bacteriological test results for *Escherichia coli* and *Salmonella sp.* were negative for all recipes.

3.2. Educational Level and Diversity of the Occupations of the Participants

Eight (8) different occupation groups of participants were identified: government employees (7.2%), housewives (20%), labor (11.1%), students (33.3%), researchers (6.7%), private jobs (8.3%), teachers (3.3%), and businessmen (10%). Among the selected panelists, the education level was illiterate (6.5%), school passed (46.9%), undergraduate (35%), and postgraduate (11.7%) (Table 3).

3.3. Response of the Participant to the Different Evaluation Criteria of the Recipes

Participants provided their opinions on a 5-point Likert scale for each chosen criterion, which included external appearances, taste, odor, juiciness, crispiness, overall acceptability, and price of the recipes; the mean value of the scale is documented in Table 4. The mean score of the Likert-scale assessment and the significant variability among the recipes for each assessment criterion (based on the mean rank score) are discussed below.

3.3.1. External Appearance

The recipes with the highest mean values for external appearance among groups A, B, and C were A2 (3.950 ± 0.649), B2 (4.137 ± 0.698), and C2 (4.233 ± 0.945), respectively (Table 4). No significant variations were observed in the mean rank values of the Likert scale among the recipes in Group A ($p > 0.05$). B1-B2 and B3-B2 in group B and C3-C2 in group C showed statistically significant differences (Table 5).

3.3.2. Taste

A2, B2, and C2 from recipe groups A, B, and C, received the highest mean scores on taste from panelists as 4.217 ± 0.761 , 4.417 ± 0.850 , and 4.150 ± 0.777 , respectively (Table 4). A notable significant difference was found between recipes A1-A2, B3-B1, B3-B2, B1-B2, C3-C2, and C1-C2, indicating variability among the panelists regarding recipe taste preference ($p < 0.05$) (Table 5).

3.3.3. Odor

In Group A, recipe A2 achieved the highest mean score (3.983 ± 0.748) for odor preference of supplied recipes. B2 and C2 from Groups B and C had the highest mean scores of 4.033 ± 0.663 and 4.167 ± 0.806 , respectively (Table 4). A1-A3, A1-A2, B1-B2, and C3-C2 exhibited significant variability in the panelists' odor preferences ($p < 0.05$) (Table 5).

3.3.4. Juiciness

For the assessment criterion of juiciness, the recipes from groups A, B, and C with the highest mean scores from the panelists were A2 (4.000 ± 0.611), B2 (3.817 ± 0.537), and C2 (4.250 ± 0.680) (Table 4). The juiciness of recipes from groups A and B did not differ significantly from one another ($p > 0.05$); however, the variation between C3-C2 and C1-C2 from group C was significant ($p < 0.05$) (Table 5).

Table 2. Nutritional factors such as moisture (M), crude protein (CP), crude fiber (CF), crude fat (EE), ash, calcium (Ca), and phosphorus (P) content analysis of the formulated ready-to-eat shrimp and fish products

Recipe group	Recipe code	(M) %	(CP) %	(CF) %	(EE) %	Ash %	(Ca) %	(P) %
A (Shrimp)	A1	4.61	28.53	7.20	37.59	7.31	0.8	0.43
	A2	4.37	33.08	4.25	34.00	8.96	0.9	0.41
	A3	4.40	41.65	3.20	29.00	10.41	0.9	0.41
B (Bombay duck)	B1	6.91	17.85	8.08	46.38	6.52	1.1	0.43
	B2	6.38	22.75	6.25	41.67	9.00	1.2	0.46
	B3	6.31	23.10	5.93	41.60	8.87	1.5	0.50
C (Ribbon fish)	C1	5.57	30.8	7.55	34.90	5.93	0.9	0.41
	C2	5.20	34.13	6.00	34.88	6.08	1.0	0.45
	C3	4.96	37.45	4.85	31.82	7.47	1.0	0.43

Table 3. Detailed scenario of the educational level and occupations of the chosen participants who participated in the panel test. The values of both categories were expressed in percentages (%)

Factors	Name	Percentages (%)
Occupation	Government employee	7.2
	Housewife	20.0
	Labor	11.1
	Student	33.4
	Researcher	6.7
	Private job	8.3
	Teacher	3.3
	Businessmen	10
Education level	Illiterate	6.5
	School Passed	46.9
	Undergraduate	35.0
	Postgraduate	11.7

Table 4. Mean score comparison of recipe groups (expressed as mean $\pm$ SD) for each assessment criterion, such as external appearances, taste, odor, juiciness, crispiness, price, and overall acceptability. Values were obtained from the 5-point based Likert scale; 1 = not acceptable, 2 = less acceptable, 3 = acceptable, 4 = moderately acceptable, and 5 = strongly acceptable

Recipe group	Recipe code	External appearances	Taste	Odor	Juiciness	Crispiness	Price	Overall acceptability
A	A1	3.800 $\pm$ 0.798	3.800 $\pm$ 0.659	3.283 $\pm$ 1.106	3.717 $\pm$ 0.865	3.833 $\pm$ 0.847	2.800 $\pm$ 0.935	3.817 $\pm$ 0.725
	A2	3.950 $\pm$ 0.649	4.217 $\pm$ 0.761	3.983 $\pm$ 0.748	4.000 $\pm$ 0.611	4.100 $\pm$ 0.730	4.267 $\pm$ 0.686	4.067 $\pm$ 0.800
	A3	3.767 $\pm$ 0.909	3.950 $\pm$ 0.649	3.800 $\pm$ 0.755	3.883 $\pm$ 0.865	3.983 $\pm$ 0.748	2.033 $\pm$ 1.025	4.017 $\pm$ 0.701
B	B1	3.583 $\pm$ 1.197	3.800 $\pm$ 0.917	3.400 $\pm$ 1.028	3.667 $\pm$ 0.572	3.833 $\pm$ 0.886	3.383 $\pm$ 1.391	3.700 $\pm$ 0.788
	B2	4.137 $\pm$ 0.698	4.417 $\pm$ 0.850	4.033 $\pm$ 0.663	3.817 $\pm$ 0.537	4.133 $\pm$ 0.892	4.433 $\pm$ 0.621	4.167 $\pm$ 0.457
	B3	3.833 $\pm$ 0.886	3.217 $\pm$ 1.027	3.750 $\pm$ 0.728	3.717 $\pm$ 0.783	3.800 $\pm$ 0.732	2.783 $\pm$ 1.403	3.633 $\pm$ 0.863
C	C1	3.917 $\pm$ 0.944	3.633 $\pm$ 0.956	3.800 $\pm$ 0.917	3.950 $\pm$ 0.699	3.767 $\pm$ 0.909	3.117 $\pm$ 1.091	3.783 $\pm$ 0.739
	C2	4.233 $\pm$ 0.945	4.150 $\pm$ 0.777	4.167 $\pm$ 0.806	4.250 $\pm$ 0.680	4.283 $\pm$ 0.958	4.283 $\pm$ 0.691	4.200 $\pm$ 0.860
	C3	3.783 $\pm$ 0.993	3.683 $\pm$ 0.965	3.633 $\pm$ 0.950	3.833 $\pm$ 1.028	4.000 $\pm$ 1.135	2.717 $\pm$ 1.379	3.583 $\pm$ 1.094

Table 5. Variability analysis among the participants' feedback for the provided recipe based on the achieved mean rank score from a 5-point Likert scale where values were assigned with 1 = not acceptable, 2 = less acceptable, 3 = acceptable, 4 = moderately acceptable, and 5 = strongly acceptable

Variable	Recipe group	Test statistic	p-value	Pairwise comparison
External Appearance	A	1.377	0.502	-
	B	11.023	0.004	B1-B2, B3-B2
	C	7.942	0.019	C3-C2
Taste	A	10.392	0.006	A1-A2
	B	41.817	0.001	B3-B1, B3-B2, B1-B2
	C	10.552	0.005	C3-C2, C1-C2
Odor	A	14.792	0.001	A1-A3, A1-A2
	B	17.062	0.001	B1-B2
	C	11.126	0.004	C3-C2
Juiciness	A	2.857	0.240	-
	B	2.633	0.268	-
	C	8.428	0.015	C3-C2, C1-C2
Crispiness	A	3.37	0.185	-
	B	6.741	0.034	B3-B2
	C	10.543	0.005	C1-C2
Price	A	93.892	0.004	A1-A2, A3-A2
	B	41.969	0.0003	B3-B1, B3-B2, B1-B2
	C	40.062	0.0007	C3-C2, C1-C2
Overall acceptability	A	14.764	0.009	A2-A1, A2-A3
	B	18.348	0.003	B3-B2, B1-B2
	C	13.139	0.001	C3-C2, C1-C2

3.3.5. Crispiness

According to the participants' responses, A2 (4.100 $\pm$ 0.730), B2 (4.133 $\pm$ 0.892), and C2 (4.283 $\pm$ 0.958) had the highest mean crispiness scores in Groups A, B, and C, respectively (Table 4). B3-B2 and C1-C2 showed statistically significant differences in mean rank scores for crispiness ($p < 0.05$) (Table 5).

3.3.6. Price

Participants passed their judgments on the given price for the recipes using a hedonic scale score. The highest mean scores were obtained for recipes A2 (4.267 $\pm$ 0.686), B2 (4.433 $\pm$ 0.621), and C2 (4.283 $\pm$ 0.691) in groups A, B, and C (Table 4). Significant differences in price preferences were observed among the panelists between

recipe A1-A2, A3-A2, B3-B1, B3-B2, B1-B2, C3-C2 and C1-C2 ($p < 0.05$) (Table 4).

3.3.7. Overall Acceptability

The panelists considered all criteria discussed above to provide feedback on the supply recipe's overall acceptability. The highest mean scores for overall acceptability were observed for recipes A2 (4.067 ± 0.800), B2 (4.167 ± 0.457), and C2 (4.200 ± 0.860) in groups A, B, and C, respectively (Table 4). A2-A1 and A2-A3 from group A, B3-B2 and B1-B2 from group B, and C3-C2 and C1-C2 from group C showed significant variability in terms of the overall acceptability of the supplied recipes ($p < 0.05$) (Table 5).

According to Table 4, recipes A2 (50% shrimp), B2 (50% Bombay duck), and C2 (50% Ribbon fish) had better mean scores than the other recipes from groups A, B, and C, respectively. Table 5 shows that, in most cases, recipes A2, B2, and C2 showed statistically significant variations from the others. Therefore, regarding the mean hedonic scale and mean rank score variations, panelists preferred recipes A2, B2, and C2 from recipe groups A, B, and C.

3.4. Influence of the Gender and Age of the Participants on the Overall Acceptability

Overall acceptability was the key assessment criterion in this study. The percentages of the Likert scale values varied with participant age and sex in terms of overall acceptability. To better understand the influence of gender and age on the participant recipe preference, Spearman's

rank correlation ($n=60$) was calculated between the overall acceptability-gender and overall acceptability-age classes at a 95% confidence interval, and the results are shown in Table 6.

A2, B2, and C2 had the highest overall acceptability among the male and female participants because they had higher acceptability percentages in the “moderately acceptable” and “strongly acceptable” criteria than in the other recipes. Recipe A2 from group A had better overall acceptability from the female participants (strongly acceptable = 36.3%), as well as from the male participants (strongly acceptable = 24.7%), than the others (Figure 2). In group B, recipe B2 was found to be strongly acceptable (23.3%), moderately acceptable (73.4%), and acceptable in 3.3% of the male participants, whereas it was strongly acceptable in 16.7%, moderately acceptable in 80%, and acceptable in 3.3% of the female participants. Male panelists rated recipe C2 as strongly acceptable (50%), moderately acceptable (23.3%), and acceptable (26.7%), whereas female panelists rated it as moderately acceptable (44.7%) to strongly acceptable (40%). None of the male or female panelists rated recipes A2, B2, or C2 as not acceptable or less acceptable. Less than 10% of male and female participants classified recipes B1, B3, and C3 as less acceptable or not acceptable (Figure 2).

The percentage of participants of different ages varied in their responses to the recipes' overall acceptability. Fig. 3 shows that in most cases, recipes A2, B2, and C2 were moderately acceptable to all age classes of the participants. None of the age-class participants rated recipes A2, B2, or C2 as less acceptable or unacceptable.

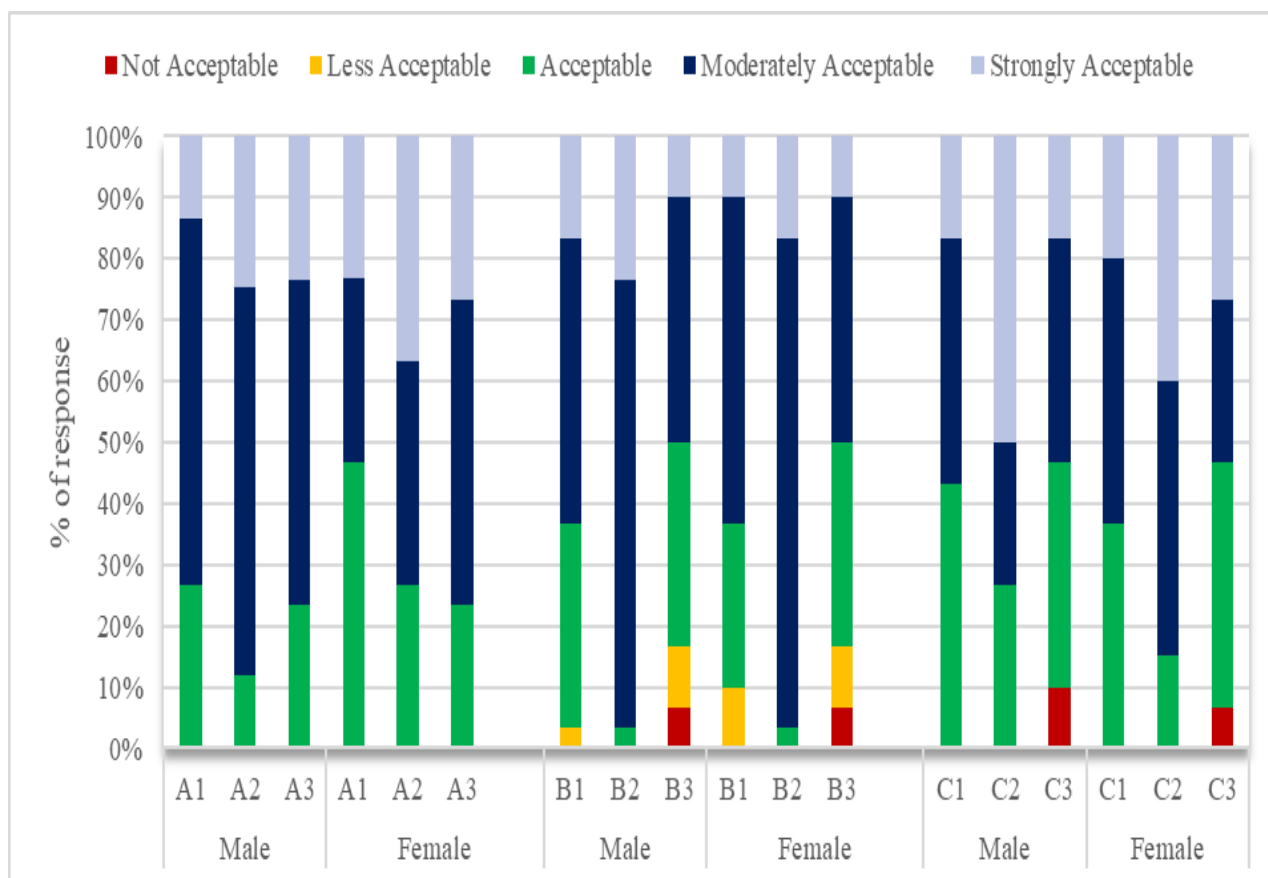


Figure 2. Percentage of the response of the panelist on the overall acceptability based on their gender in the 5-scale based Likert scale (1 = Not Acceptable, 2 = Less Acceptable, 3 = Acceptable, 4 = Moderately Acceptable, 5 = Strongly Acceptable)

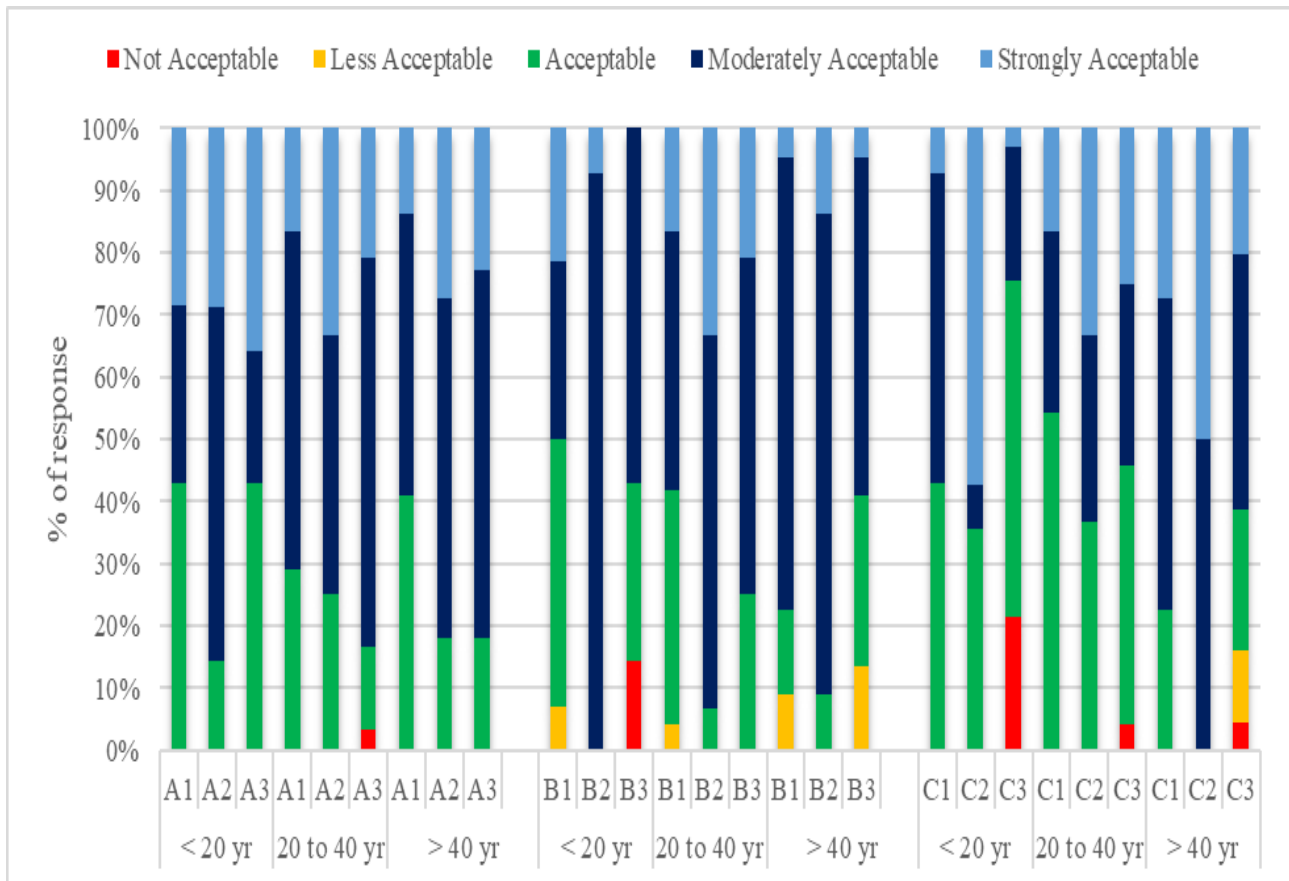


Figure 3. Percentage of the response of the panelist on the overall acceptability based on the age class in the 5-scale based Likert scale (1 = Not Acceptable, 2 = Less Acceptable, 3 = Acceptable, 4 = Moderately Acceptable, 5 = Strongly Acceptable)

Although the participants varied in the percentage of their responses based on their age and gender, no strong significant correlation was observed between age class overall acceptability and overall gender acceptability ($p > 0.05$) (Table 6). The findings indicated that the sex and age of the participants did not influence their preference.

Table 6. Spearman's coefficient of correlation (r) of the relationship between general acceptance and gender and between gender and overall acceptability with a 95% confidence interval ($n = 60$)

Recipe code	Spearman's correlation between age class and overall acceptability		Spearman's correlation between gender and overall acceptability	
	Correlation coefficient (r)	Correlation coefficient (r)	Correlation coefficient (r)	Significance level ($P = 0.05$)
A1	-0.07	-0.094	-0.094	0.476
A2	-0.022	0.008	0.008	0.949
A3	0.054	0.024	0.024	0.854
B1	0.076	-0.063	-0.063	0.634
B2	-0.069	-0.076	-0.076	0.565
B3	-0.015	0.291	0.291	0.240
C1	0.236	0.070	0.070	0.597
C2	0.138	-0.025	-0.025	0.851
C3	0.397	0.063	0.063	0.068

4. Discussion

The process by which humans accept or reject food is multi-dimensional. Consumer responses to a product vary with sensory characteristics and inherent qualities [30,31]. Close interactions between food and consumers determine food acceptance. Consumer preferences can vary according to their characteristics, including attitudes, behaviors, and origins [32,33]. According to different previous studies, sociodemographic characteristics, including age, gender, and educational attainment, have an impact on food consumers' purchase decisions [34,35]. Thus, this study incorporated participants from eight

divisions and 29 districts of Bangladesh to provide greater area coverage and to include diversified consumers of different ages, genders, education levels, and occupations (Table 3). The diverse origins of the participants made the test findings more precise and factual.

Physical, chemical, and nutritional characteristics determine the acceptability of food to consumers [36]. This is significant since learning about a product and forming opinions about it are related to the first step of the decision-making process [37]. This study analyzed the proximate composition of value-added fish and shrimp products in terms of moisture, crude protein, crude fiber, crude fat, ash, and minerals (Ca and P). Crude protein and

crude lipid percentages were higher in products with a high percentages of dried fish and shrimp content (Table 2). The percentages of these nutrients were not similar to the proximate composition of dried mixed shrimp (*Palaemon karnafuliensis*, *Metapenaeus Monoceros*, and *Ferapenaeus indicus*) [38], dried Bombay duck (*Harpadon nehereus*), and dried ribbon fish (*Trichiurus savala*) [39]. The proximate composition of any product can vary depending on the processing method [40,41]. Because the recipes in this study were produced using various species and other components, such as oil, red chili powder, turmeric powder, and onion, they did not match with the proximate composition cited above.

The development of a new product must consider the consumer's perspective [42]. Food acceptance depends on whether it responds to consumer needs and the degree of satisfaction that it can provide. End-product preference is normally calculated based on consumers' perception of a product's overall appearance, taste, color, odor, and texture [26]. Hedonic tests are used to evaluate acceptance to determine how much users prefer particular sensory aspects of a product [14]. In this study, recipes A2, B2, and C2 were within the acceptable to highly acceptable range (based on the Likert scale value) for the participants in terms of external appearance, taste, odor, juiciness, crispiness, and overall acceptability (Table 4). Consumer acceptance studies of value-added fishery products by [43] also agree with these findings, as their products were found to be acceptable in terms of similar sensory criteria.

People worldwide are now seeking food attributes like convenience, flavor, quality, and low prices as consumer needs are changing [44]. Along with the extrinsic and inherent quality of products, consumer perceptions greatly depend on the price of products [45]. The panelists in this study were more satisfied with the given prices of recipes A2, B2, and C2 than the other recipes within the product groups (Table 4).

The present study found significant variations among recipes, with the highest acceptability percentage in recipes A2, B2, and C2 among the three recipe groups (Table 5). This variation could be due to consumer perceptions [46] and different ingredient compositions, with varying amounts of fish muscle in their products [43,46]. For instance, fish protein snacks with 9% fish protein powder had the lowest preference, while snacks with 3%, 5%, and 7% fish protein had equal preferences for odour, texture, flavor, and overall acceptability in a previous study [47].

Age, gender, and environment have an impact on the extent of food acceptability. Significant differences ($P < 0.05$) were found between ages, where the younger and older ages preferred different recipes in some previous studies also [48]. The present study found no significant correlation between overall product acceptability and age or gender ($p > 0.05$). Both male and female participants rated recipes A2, B2, and C2 more than the others, similar to the panelists' age groups. Age and sex did not influence panelist's preferences in this study (Table 6).

The overall study findings indicated that recipes A2 (50% shrimp), B2 (50% bombay duck), and C2 (50% ribbon fish) were the products most rated and accepted by

the panelists due to their better quality than the other recipes. Participants of different ages and sex also provided positive feedback on these recipes. Therefore, these recipes could be the best formulations to produce and market ready-to-eat Balachao from shrimp, Bombay duck and ribbon fish.

5. Conclusion

This study concluded that a recipe composed of 50% dried shrimp and fish, with other ingredients, had better quality and the highest acceptance rate among the consumer. The chosen recipes have potential market opportunities in Bangladesh's value-added fishery products industry. Formulating value-added products from the recipes recommended in the present study would help proper utilization of underutilized fish and shrimp resources. Through a proper marketing strategy, the products might reach to the consumer and the fishery product industries of Bangladesh will be benefited. This could also help lessen fishing pressure on a fishery resource that is currently overfished.

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Competing Interest

The authors declare no competing interest.

List of Abbreviations

AOAC: association of official analytical chemists, ID: identification number, SPSS: statistical package for social science, SD: standard deviation, M: moisture, CP: crude protein, CF: crude fiber, EE: crude fat, Ca: calcium, P: phosphorus, DoF: Department of Fisheries, GDP: Gross Domestic Product, RTE: ready-to-eat.

Data Availability Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval Statement

The research methodology for this investigation was approved in accordance with the standard policies and procedures of the Ecological Laboratory, Department of Fisheries Resource Management, Faculty of Fisheries, Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh. All participants were declared constant regarding their participation in the research process in the provided questionnaire. Documented approval was obtained from the ethical approval committee of the Department of Fisheries Resource Management, CVASU, prior to the start of the study.

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