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Unveiling the potential: Food safety, consumer segmentation in Thailand's snakehead fish market

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Article Info

Abstract

This study aims to analyze factors influencing the decision-making process of snakehead fish consumers and to group consumers based on their behavior and preferences. Two methods were employed: factor analysis to identify decision-making factors and non-hierarchical cluster analysis to segment consumers. The target populations were selected from areas with large numbers of snakehead fish consumers. The study collected data through phone and online interviews with 472 snakehead fish consumers using stratified random sampling. The result indicated that food safety and nutrition were the primary influencing factors for snakehead fish consumption decisions. Concern about food safety when considering the cleanliness and safety of processed snakehead fish were also crucial factors for consumers. Two distinct consumer groups were identified based on demographic factors and the specific characteristics of snakehead fish desired by consumers. These findings provide insights for developing targeted marketing strategies and emphasize the importance of food safety measures and standardized production processes in the snakehead fish market. Implementing Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) is recommended to ensure consumer safety and promote the growth of the snakehead fish industry. In addition, more processed fish should be promoted to reach younger consumers.

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Introduction

Freshwater fish are popular among Thai consumers as a low-cost protein source compared to seafood or farmed coastal fish. Among them, snakehead fish, both wild-caught and farmed varieties, have long been consumed in Thailand, contributing to the country's economy as an important source of income and employment. In the past, snakehead fish were challenging to breed in captivity, and it was necessary to obtain breeding stock from the wild. While the successful development of breeding techniques for snakehead fish by the Department of Fisheries has resulted in a significant increase in its commercial farming in Thailand, the species' consumption has not grown significantly. This could be attributed to traditional preparation methods, which primarily appeal to the older generation, whereas the younger generation generally prefers modern or fusion cuisine. The Thai snakehead fish market faces stiff competition from tilapia and snapper fish, which have enjoyed a higher preference in comparison. Henceforth, an outcome of this has been a diminution in the quantity of snakehead fish consumed within Thailand. Moreover, the availability of imported snakehead fish at lower prices than domestically produced ones has created an oversupply problem in the Thai market, leading to a price decrease. This situation has driven snakehead fish farmers to their limits and forced many out of business. To mitigate the issue of surplus supply in the market, it is imperative to augment the demand for snakehead fish within the market.

In the pursuit of market expansion, it is imperative to gain a comprehensive understanding of consumer behavior pertaining to fish consumption. When consumers engage in the process of making purchasing decisions regarding fish, they are frequently influenced by a range of elements. These factors encompass socio-demographic traits, product characteristics, and, notably, the nutritional and health benefits that are conveyed through nutritional and eco-labels. (Marette et al., 2008; Rickertsen et al., 2017). Other factors that exert influence encompass aspects pertaining to health and the assurance of food safety. There exists a notable level of apprehension regarding the potential health hazards associated with the occurrence of methylmercury, dioxins, and dioxin-like polychlorinated biphenyls (PCBs) in fish. Currently, there is a limited body of academic research that explores the level of concern among Thai consumers regarding food safety in relation to their fish consumption.

The objective of this study is to categorize the consumer demographics according to many factors, such as food safety concerns, nutritional awareness, value perception, consumption patterns, ease of purchase, and sensory preferences. Accurately identifying the target consumer group is a crucial factor in executing effective marketing strategies. It enables the tailoring of marketing efforts to meet the needs and preferences of that specific group. Targeting the wrong consumer group can result in ineffective marketing efforts and the waste of resources. Grouping consumers according to their preferences could be beneficial in understanding the behavior of the target consumers. The study concerning the consumption behavior of fish and fish products in Thailand pertains to a comprehensive analysis of general fish consumption patterns. Notably, it has been ascertained that purchasing decisions related to fish are significantly impacted by factors including branding and freshness. (Nonthapot & Sompholkrang, 2018; Srisakun et al., 2015) Nonetheless, it has been observed that there is still an absence of studies on the behavior of fish consumers within different groups in Thailand.

Knowledge of the behavior of snakehead fish consumers can be used to develop strategies to increase its market demand and boost its consumption in Thailand. Therefore, this study aims to analyze factors affecting the decision-making of snakehead fish consumers as well as analyze and group consumers of snakehead fish based on their behavior and preferences with the intention of applying the outcomes of the study to inform the implementation of Thailand's policy concerning the expansion of the snakehead fish market.

Literature Review

Studies have found that consumers in Europe are increasingly opting for safe and healthy fish products, resulting in higher prices as producers invest in measures to ensure product safety and quality. Marette et al. (2008) explored the difficulties in communicating health risks and benefits related to fish consumption to the public. In an experiment conducted in France to evaluate the impact of health information on consumer choices regarding fish consumption, they found that the order of information and recommendations mattered. Discussing benefits before risks helps improve the efficiency of communication as consumers feel more optimistic, open-minded, and less apprehensive about the risks that follow. The research also found that consumers placed significant value on health information, which affected the price they were willing to pay for the product. According to Rickertsen et al. (2017), French consumers perceive wild

fish as the best option for safety and health, while farmed fish is considered the best for environmental sustainability and fish welfare. Salmon was ranked the highest across many attributes and gained the highest willingness to pay from consumers. In the context of fish consumption, information about the area of origin and production method can be important indicators of safety, sustainability, and quality, which may increase consumers' willingness to pay. Using a hedonic price model analysis, Lesur-Irichabeau et al. (2016) identified intrinsic product characteristics (size, freshness, and quality), market situations (supply and demand dynamics), and the characteristics of operators (loyalty between sellers and buyers and market assiduity) as some of the factors influencing the price of scallops in primary fish markets in France. Based on a similar approach, Bronnmann and Asche (2015) examined factors determining the price of seafood in the European Union market and found that branded and farm-raised products tended to have a higher price, while private label products received a price discount. They also highlighted the importance of safe and sustainable production methods, eco-labels, and promotions in determining seafood prices. In addition, Leek et al. (2000) found that factors that influence UK consumers' choice of fish were mainly environmental, based on a behavioral perspective model. They categorized consumers' beliefs about fish consumption into five components: versatility, situational relevance, negative properties, economy, and convenience. In 2022, Galati et al. conducted a cross-country study utilizing ordinal logistic regression to examine the characteristics that influenced customers' attention to fish eco-labels in their buying decisions. The results of the study suggest that Italian and Spanish customers who possess an altruistic mindset and believe that sustainably produced food can contribute to environmental preservation and worker well-being are more inclined to consider the presence of an eco-label when making purchasing decisions. Furthermore, there is a notable inclination among consumers who possess a higher level of education and those who fall within the older age bracket to engage in the practice of reviewing eco-labels prior to their acquisition of fish goods.

A study conducted in 2021 by Witter et al. examined consumer preferences for seafood in Canada, focusing on alternative food networks (AFNs). AFNs are characterized by diverse value chains that involve small-scale, localized fishing operations and offer traceable, sustainable, and high-quality seafood products to Canadian consumers. The findings of the survey indicated that the prevailing seafood species ingested by individuals were salmon, tuna, and shrimp. Consumers exhibited a preference for

many product quality criteria, such as taste, appearance, freshness, price, health advantages, and the specific type of seafood. Furthermore, consumer apprehension has expanded to encompass sustainability, production techniques, and equitable remuneration for harvesters in instances of wild-caught seafood. The study proposed several measures to improve the efficiency of seafood AFNs, including prioritizing the delivery of high-quality items, implementing competitive pricing strategies, and strategically targeting certain consumer categories in emerging economies.

Baptista et al. (2020) conducted a study in Brazil to determine the levels of seafood consumption, evaluate the safety methods employed during seafood handling and preservation, and assess the customers' perception of associated risks. The findings of the study indicate that the Brazilian participants exhibited a lack of awareness of seafood illness outbreaks and were unable to identify reliable sources for purchasing seafood. This knowledge gap may contribute to an increased risk of microbiological contamination. Additionally, their knowledge of the safety of seafood, ranging from the point of purchase through the process of preparation, was lacking. Individuals who were born during the baby boom era and have attained a postgraduate education level, particularly females, exhibited a more favorable perception regarding microbiological risk and the significance of safety measures. This was evident in their positive attitudes towards thawing procedures for seafood and their awareness of the potential health hazards associated with consuming raw seafood.

Singh et al. (2014) showed that demand and price elasticity for fish in the United States varied across species, seasons, and geography. The degree of competition among fish products also varied considerably over time, and the products themselves changed, particularly the substitution between catfish and tilapia in the U.S. markets. Furthermore, Matuli et al. (2016) identified three different groups of consumers of fresh fish in Croatia using factor and cluster analysis: fresh fish lovers, fresh fish advocates, and occasional consumers of fresh fish. The segments differed in terms of their behavior, barriers to fresh fish consumption, attitudes toward fresh fish, roles of the media and food industry, and socio-demographic characteristics. Identifying these different attitudes and barriers to fresh fish consumption and socio-demographic features may provide an opportunity for fish producers to develop marketing strategies that will meet the demands of different consumers.

There is limited research available on consumers' preferences for fish and fish products in Thailand. Srisakun and Santiteerakul (2015) identified the most important factors that influence consumer behavior when purchasing canned fish in Bangkok. According to their research, the highest-ranked

factor was the logo, followed by the label color, taste of the product, brand trustworthiness, clear and complete nutritional information on the label, size of the fish pieces in the can, quantity of fish pieces in the can, and the presence of a halal logo. Nonthapot and Sompholkrang (2018) found that freshness and cleanliness were the most important factors for consumers in the upper northern area of Thailand when purchasing natural fresh fish and processed fish products. Chokenukul et al. (2019) found that the purchasing behavior of Thai consumers toward processed fish products was significantly influenced by consumer-related factors, such as perception of product quality, family members' opinions, mood, attitude, and health consciousness, as well as external factors, including the product price and store environment suitability. They also showed that these causal variables could collectively account for 58 percent of the variance in consumer purchasing behavior regarding processed fish products.

Methodology

Data Collection

Primary data were obtained by phone, accounting for 42 percent, and online interviews, accounting for 58 percent, with snakehead fish consumers during 2020. For the sample selection, stratified random sampling was applied as follows: First, we selected the representative areas with large numbers of snakehead fish consumers. Next, we separated the areas by regions, and then we randomly selected consumers of snakehead fish in our study areas. Prior to data collection, approval was given by Kasetsart University Research Ethics Committee (COE number: COE63/010). Therefore, all the interviews in this study were based on voluntary participation. Prior to the interview, the purpose and details of the study were explained to the respondents, and they were asked to provide verbal consent. The respondents were allowed to leave the interview at any time. Personal information of the respondents, such as names and phone numbers, were not used for the analysis to ensure the confidentiality of the study. The purposive sampling was done purely on the targeted population with no discrimination on any sensitive factors such as gender or race. None of the questions in the questionnaire were associated with any controversial issues that could cause mental or physical harm to the respondents. A total of 472 participants were selected, as shown in Table 1.

The questionnaires comprised four distinct sections: (1) socioeconomics of the correspondences; (2) behaviors related to freshwater fish consumption; (3) preferences regarding the consumption of fresh snakehead fish; (4) preference for processed snakehead fish attributes; and (5) attitudes toward snakehead fish are assessed using a Likert scale ranging from 1 (indicating the lowest level of concern) to 5 (reflecting the highest level of concern).

Data Analysis

In this study, two methods were applied to study the decision-making of consumers of snakehead fish. First, factor analysis was employed to categorize the variables expected to influence snakehead fish consumers' behaviors into groups. Second, cluster analysis, specifically two-step cluster analysis due to the mixed nature of the variables involved – comprising both continuous and categorical elements. This method facilitated the examination and categorization of consumers, grouping them based on their distinct characteristics and preferences. The cluster analysis was used to segment snakehead fish consumers based on two key factors: (1) demographic information such as age, personal income, household income, marriage status, and occupation; and (2) factor scores from factor analysis.

Results and Discussion

Analysis of the socio-demographic characteristics of the sample groups revealed that 70.55 percent of the consumers were female, 65.47 percent were members of households, and 46.61 percent were married. When considering their educational level, 37.92 percent of the consumers had completed their undergraduate degrees, and 26.27 percent had completed their primary education. In terms of occupation, most consumers in the central and northern regions had general labor jobs; consumers in Bangkok mostly worked as company employees; and consumers in the northeast region were mostly farmers. In terms of income, a substantial percentage of consumers (47.03%) reported a monthly income below 10,000 baht. Notably, the consumers were predominantly over 60 years old and retired. Household incomes were above 35,000 baht per month and were higher in Bangkok than in other regions.

Table 1 Number of participants in each studied area

Area	Number of participants
Bangkok and its metropolitan area	100
Central region	113
Northern region	139
Northeastern region	120
Total	472

When considering the reasons for purchasing snakehead fish, it was found that most consumers bought fresh snakehead fish to cook by themselves. Bangkok, however, had an equal proportion of consumers who bought fresh snakehead fish to cook by themselves and those who preferred buying processed snakehead fish out of convenience. Also, some considered cooking snakehead fish a complex task; others thought killing fish was sinful; and others lacked cooking skills. In terms of purchasing locations, consumers buying snakehead fish tended to follow a similar pattern as those buying other freshwater fish in general, with popular options including the fresh market, flea market, and supermarket. Regarding the substitutability between snakehead fish and other freshwater fish, it was found that consumers in Bangkok, the central region, the eastern region, and the northern region mostly saw snakehead fish as a potential substitute for Nile tilapia and catfish.

Regarding consumers' concerns about the overall safety of snakehead fish, consumers expressed concerns about the cleanliness and safety of processed snakehead fish products, the cleanliness of fresh snakehead fish, the lack of standards in fish farms, the use of antibiotics in snakehead fish farms, and chemical residues in snakehead fish. When considering consumer concerns by region, we found that consumers in Bangkok and the northern region were more concerned about the safety of snakehead fish than consumers in other regions, especially regarding the cleanliness and safety of processed snakehead fish products (Table 2).

Factor Analysis

A factor analysis was conducted to categorize the variables expected to influence snakehead fish consumers' behaviors into groups (factors), which will be later used in the cluster analysis. Principal Component Analysis was employed as the extraction method, and the rotation method used was Varimax. The Kaiser-Meyer-Olkin test returned a value of 0.835, and the Bartlett's test returned a value of 0.00, indicating that the correlation matrix used in the factor analysis is not an identical matrix and, thus, is appropriate for the analysis. We examined variables with magnitudes exceeding ±0.5 in weight, thereby ascertaining the membership of variables within each respective factor. Based on the results of the factor analysis, out of the 13 variables, two distinct factors emerged: concerns over food safety and nutrition. The details of each group of factors are as follows (Table 3).

Table 2 Consumer attitudes towards snakehead fish

Attitude	Bangkok	Central region	Northern region	Northeastern region	All regions
- Residual chemicals in snakehead fish	4.13	3.14	4.17	2.92	3.60
- Use of antibiotics in snakehead fish farming	3.98	3.19	4.06	3.46	3.68
- Diseased snakehead fish	4.16	3.83	4.13	3.53	3.91
- Non-standardized fish farms/factories	4.16	3.42	4.15	3.37	3.78
- Unclear origins of snakehead fish	3.61	2.70	3.54	2.68	3.13
- Cleanliness of fresh snakehead fish	4.24	3.65	4.19	3.49	3.89
- Confidence in eating snakehead fish from Thailand	3.27	2.37	2.94	2.75	2.83
- Cleanliness and safety of processed snakehead fish products	4.24	3.96	4.25	3.54	4.00

Note: numbers 1.00–1.80 indicate the least amount of concern, 1.81–2.60 indicate low concern, 2.61–3.40 indicate moderate concern, 3.41–4.20 indicate high concern, and 4.21–5.00 indicate the highest level of concern.
Source: From the calculation

Table 3 Factors of snakehead fish consumption behaviors based on component analysis

Factor group	Measurement variable	Weight value	Variance (%)	Cumulative (%)
1. Food safety concerns	- Chemical residues in snakehead fish	0.756	30.759	30.759
	- Use of antibiotics in snakehead fish farming	0.741		
	- Diseased snakehead fish consumption	0.689		
	- Non-standardized fish farms/factories	0.668		
	- Cleanliness of fresh snakehead fish	0.594		
	- Cleanliness and safety of processed snakehead fish products	0.546		
	- Unclear source of snakehead fish	0.568		
2. Nutritional factors	- High-quality protein content	0.654	18.901	49.660
	- High protein content	0.594		
	- Versatility in cooking	0.678		
	- Low fat content	0.611		
	- Ease of digestion	0.571		

Sources: From the calculation

1. Factors related to food safety anxiety

Variables in this group included anxiety about chemicals in snakehead fish, anxiety about the use of antibiotics in snakehead fish farming, anxiety about consuming diseased snakehead fish, anxiety about non-standardized fish farms or processing plants, anxiety about the cleanliness of fresh snakehead fish, anxiety about the cleanliness and safety of processed snakehead fish products, and anxiety about the unclear origins of snakehead fish.

2. Nutritional factors

The variables in this group were related to the characteristics of the fish, such as the high-quality protein content, versatility in cooking, low fat content, and ease of digestion.

Cluster Analysis of Snakehead Fish Consumers

By employing a two-step cluster analysis, the Schwarz's Bayesian Criterion (BIC) showed the largest decrease when transitioning from one cluster to two clusters (Table 4) suggesting that the division into two clusters was appropriate. Thus, the consumers were divided into two groups. The results of the t-test and chi-square test showed that demographic factors, preference for snakehead fish products, food safety anxiety factors, and nutritional factors significantly explained the differences among consumer groups (Table 5). Details of the cluster analysis are shown below.

Table 4 the Schwarz's Bayesian Criterion from two-step cluster analysis

Number of Clusters	Schwarz's Bayesian Criterion (BIC)	BIC Change	Ratio of BIC Changes	Ratio of Distance Measures
1	9084.196			
2	8251.104	-833.092	1.000	2.512
3	8052.827	-198.277	.238	1.323
4	7957.146	-95.681	.115	1.031
5	7871.075	-86.071	.103	1.065
6	7803.916	-67.160	.081	1.241
7	7792.797	-11.118	.013	1.054
8	7793.702	.905	-.001	1.310
9	7846.776	53.073	-.064	1.058
10	7909.026	62.250	-.075	1.044
11	7978.037	69.011	-.083	1.018
12	8049.793	71.756	-.086	1.027
13	8125.486	75.693	-.091	1.180
14	8223.395	97.909	-.118	1.019
15	8323.559	100.164	-.120	1.060

Source: From the calculations

Table 5 Characteristics of each consumer group based on the grouping results.

Variables	Consumer groups		Level of Significance
	1	2	
Number of members	261 (55.4%)	210 (44.6%)	
Age	35.7	55.68	0.000***
Living area	Bangkok (34.8%)	Central region (32.4%)	0.000***
	Northern region (25.9%)	Northern region (32.4%)	
Income	10,001–15,000 (25.4%)	<5,000 (40.5%)	0.000***
Household income	>35,000 (53.6%)	5,000–10,000 (20.6%)	0.000***
Status	Single (65.6%)	Married (64.0%)	0.000***
Occupation	Private officer (24.1%)	Self-employed (34.4%)	0.000***
	Government officer (21.4%)	Farmer (26.3%)	
Food safety concern factor	0.09	-0.09	0.050**
Nutritional factor	0.02	-0.02	0.725[n.s.]
Preference for snakehead fish products			
- Fresh snakehead fish	No (58.9%)	Yes (86.6%)	0.000***
- Ready-to-cook snakehead fish	No (79.5%)	Yes (51.0%)	0.000***
- Ready-to-eat snakehead fish	Yes (88.8%)	Yes (51.4%)	0.000***

Note: The level of significance determines whether the mean difference between groups obtained from the t-test is statistically significant for age, food safety concern factor, and nutritional factor. Meanwhile, the chi-square test is employed for other factors which are not continuous.
*, **, *** represents the level of significance at $p < 0.1$, $p < 0.05$, $p < 0.01$, and n.s. indicates non-significant relationships.
Sources: From the calculation

Group 1: Impulsive consumers

This group comprises new-generation consumers who prioritize convenience and comfort. On average, they are 36 years old, single, and reside in Bangkok and the Northern Region. They are employed in either the private sector or government sector, with an income ranging from 10,000 to 15,000 baht per month, and their household income exceeds 35,000 baht per month. Consumers in this group prefer ready-to-eat processed snakehead fish over purchasing ready-to-cook or raw ones to cook at home, reflecting the time constraints faced by modern consumers who prefer not to spend extended time on cooking. Given their concerns about food safety factors, the consumers in this group place a greater emphasis on them than those in the other group.

Group 2: Snakehead fish and purebred snakehead fish enthusiasts

Consumers in this group are classified as late middle-aged, with an average age of 56 years. They are mostly married and reside in central or northern regions. Farmers are the next largest group after self-employed people. Their personal income typically amounts to less than 5,000 baht per month, while the household income ranges from 5,000 to 10,000 baht per month. They are capable of consuming various forms of snakehead fish, including fresh snakehead fish and processed snakehead fish that are ready to cook and eat. This reflects the skills and time flexibility of elderly consumers who opt to buy fresh snakehead fish and prepare it themselves at home, while maintaining a desire for convenience and adjusting to the demands of a highly urbanized society. Consequently, they may also be open to incorporating processed food into their consumption patterns. Considering their concerns about food safety factors, the consumers in this group place less emphasis on them than those in the other group.

From the results, it is evident that all consumer groups are highly concerned about the safety of snakehead fish, particularly regarding the presence of chemical residues, the use of antibiotics, the consumption of diseased fish, substandard fish farms or processing factories, unclean fresh fish, unclean and unsafe processed products, and unclear sources of fish. Among the clusters, Group 1 is most concerned about the consumption of diseased snakehead fish, followed by the cleanliness and safety of processed fish products and the cleanliness of fresh snakehead fish. Consumers in this group are less concerned about their confidence in eating snakehead fish from Thailand. Similar attitudes are observed among consumers in the other group. Group 2 consumers express the highest concern about the cleanliness and safety of processed snakehead fish products, followed by the consumption of diseased snakehead fish. Confidence in eating snakehead fish from Thailand is also of least concern for those in Group 2 (Table 6). The least concern regarding confidence in eating snakehead fish from Thailand reflects the limited knowledge of consumers in both groups about the supply of snakehead fish. Thus, two-fifths of the snakehead fish supply was imported from neighboring countries.

Table 6 Attitude on food safety concerns of each consumer groups

Attitude	Group	
	1	2
- Residual chemicals in snakehead fish	3.43	3.74
- Use of antibiotics in snakehead fish farming	3.55	3.79
- Diseased snakehead fish	3.93	3.90
- Non-standardized fish farms/factories	3.69	3.85
- Unclear origins of snakehead fish	3.14	3.13
- Cleanliness of fresh snakehead fish	3.71	4.05
- Confidence in eating snakehead fish from Thailand	2.88	2.78
- Cleanliness and safety of processed snakehead fish products	3.91	4.08

Note: the interpretation of numbers in the table aligns with the information in Table2
Source: From the calculation

In terms of consumption behavior, each group exhibited different preferences for snakehead fish characteristics. Consumers in Group 1 showed a stronger preference for dense taste over sweet taste, whereas Group 2 consumers placed a higher value on sweet taste (Table 7). When considering the attributes of fresh snakehead fish that influenced consumers' purchasing decisions, it was found that consumers in both groups prioritized the fish smell, followed by the size. The price factor had a greater impact on the decision-making of Group 2 consumers compared to those in Groups 1 and 2 (Table 8).

Consumers generally preferred wild snakehead fish over farmed snakehead fish and local species over imported ones. For the desired fresh snakehead fish form, consumers preferred whole decorated snakehead fish. The maximum price of farmed snakehead fish should not exceed 149.21 baht per kilogram. As for the maximum price of wild snakehead fish, it should not exceed 144 baht per kilogram.

Table 7 Preferences for snakehead fish characteristics

Snakehead fish characteristics	Group		Overall
	1	2	
Sweet taste	54.9%	72.1%	63.9%
Dense meat	69.2%	57.5%	63.1%
Less bone	39.7%	51.8%	46.1%
Fibrous flesh	12.5%	18.2%	15.5%
Less fat	32.6%	32.0%	32.3%
Tender flesh	24.6%	25.9%	25.3%
Milder smell	27.2%	28.7%	28.0%

Note: Numbers in this table represent percentage of consumer in each group
Source: From the calculations

Table 8 The attributes of fresh snakehead fish that influenced consumers' purchasing decisions.

Snakehead fish attributes	Group		Overall
	1	2	
Fish size	23.9%	22.9%	23.2%
Smell	42.4%	42.1%	42.2%
Freshness	0.0%	1.4%	1.0%
Color	2.2%	0.9%	1.3%
Price	7.6%	13.6%	11.8%
Fish taste	2.2%	0.5%	1.0%
Source of fish (domestic/imported)	0.0%	0.5%	0.3%
Filed caught fish	8.7%	10.6%	10.0%
Living fish	8.7%	4.6%	5.8%
Convenience	3.3%	1.8%	2.3%

Note: numbers in this table represent percentage of consumer in each group
Source: From the calculations

Moreover, consumers preferred dried snakehead fish, chilled sliced or cubed snakehead fish. They also favored chilled dressed snakehead fish, which are ready to cook, with the head, tail fins, and all internal organs removed. They also showed a preference for seasoned snakehead fish sets for cooking. Popular processed snakehead fish products for consumption include steamed fish, deep-fried snakehead fish, and snakehead fish chili paste. Consumers also preferred packaging that ensured processed snakehead fish products were odor-proof, easy to open, and capable of long-term storage, with information such as the manufacturing and expiration dates, nutritional details, and relevant certifications.

Conclusions and recommendations

The findings of our study indicate that customer perceptions of the consumption of snakefish mostly focus on the hygienic and safety aspects of processed snakehead fish products, as well as the presence of diseases and the cleanliness of fresh snakehead fish. When examining the research conducted by Nonthapot and Sompholkrang (2018), it becomes evident that Thai consumers place considerable emphasis on the freshness and hygiene of food products. The result illustrates a growing tendency among customers to place a higher emphasis on food safety as opposed to freshness and cleanliness.

Moreover, the component analysis conducted in the study revealed that Thai consumers of fish exhibit a higher degree of awareness regarding food safety, which is equivalent to that of consumers in developed nations, such as European countries. According to the study conducted by Rickertsen et al. (2016), the primary factors that significantly affect consumers' decisions regarding their consumption of snakehead fish are food safety concerns, followed by considerations related to nutrition.

Two separate consumer groups are established in consumer segmentation based on demographic criteria and the unique attributes of snakehead fish that consumers find desirable. The research findings are consistent with the results of Matuli's (2016) study, which suggest that consumer groups characterized by a younger demographic, namely, the Impulsive Consumers, demonstrate a reduced attitude towards inconvenience when it comes to their fish consumption. As a result, they exhibit a strong inclination towards consuming solely pre-packaged snakehead fish, displaying no discernible preference for fresh snakehead fish or snakefish intended for culinary preparation. The second group, which consists of people from an older age group, exhibits an ability to consume snakehead fish in its fresh form as well as in the form of ready-to-cook and ready-to-eat preparations.

When examining attitudes towards food safety concerns, it is evident that all consumer groups demonstrate a notable degree of anxiety regarding the cleanliness and safety of processed fish products. Additionally, there is a common concern among consumers regarding the hygiene of fresh snakehead fish and the potential risks associated with consuming diseased snakehead fish. Surprisingly, the source of snakehead fish does not appear to be a prominent consideration for consumers. The observed observation exhibits a contrast to the research conducted by Rickertsen et al. (2017) in France, wherein the emphasis on the geographical source of fish among consumers was underscored, indicating their concerns over food safety

indicators. When considering consumption behavior, it is important to note that there is a differentiation in the factors that impact the buying choices made by each customer demographic. Group 1 assigns greater significance to the attribute of density, while Group 2 tends to prioritize the sensory characteristic of sweetness.

The segments exhibited variations with regards to socio-demographic characteristics, behavior, and food safety. The identified parameters give a full explanation for the observed disparities among customer groups, thereby presenting an opportunity for snakehead fish producers to develop marketing strategies that effectively respond to the diverse consumer preferences.

Therefore, it is essential for a comprehensive strategy aimed at fostering the snakehead market in Thailand to take into account several dimensions of food safety, with particular emphasis on concerns related to chemical residues, diseased snakehead fish, non-standardized fish farms and factories, as well as the source of snakehead fish. Therefore, it is crucial to advocate for the adoption of production and processing standards, such as Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP), for both snakehead fish that are developed on farms and those that undergo processing. Additionally, it is essential to enforce rigorous procedures aimed at preventing the presence of residues in imported fish.

Moreover, it is important to mention that a considerable segment of the current consumer demographic for snakehead fish comprises senior consumers. In order to enhance the market reach of snakehead fish, it is crucial to shift our focus towards engaging younger consumers. This objective can be attained by implementing smart promotional and marketing strategies that highlight the accessibility of processed fish products, with a particular focus on catering to the needs and preferences of younger consumers. Examples of such products include readily consumable alternatives to snakehead fish. Through the implementation of this strategy, it is possible to successfully engage and attract the younger demographic of consumers, consequently promoting expansion and long-term viability within the snakehead fish industry.

Conflict of Interest

The authors declare that there is no conflict of interests.

References

Baptista, R. C., Rodrigues, H., & Sant'Ana, A. S. (2020). Consumption, knowledge, and food safety practices of Brazilian seafood consumers. *Food research international*, 132, https://doi.org/10.1016/j.foodres.2020.109084

Bronnmann, J., & Asche, F. (2016). The value of product attributes, brands and private labels: an analysis of frozen seafood in Germany. *Journal of Agricultural Economics*, *67*(1), 231–244. https://doi.org/10.1111/1477-9552.12138

Chokenukul, P., Sukhabot, S., & Rinthaisong, I. (2019). A causal relationship model of purchasing behavior of consumers in Thailand regarding processed fish products. *Kasetsart Journal of Social Sciences*, *40*(2), 366–372. https://so04.tci-thaijo.org/index.php/kjss/article/view/242163 [In Thai]

Galati, A., Miret-Pastor, L., Siggia, D., Crescimanno, M., & Fiore, M. (2022). Determinants affecting consumers' attention to fish eco-labels in purchase decisions: A cross-country study. *British Food Journal*, *124*(10), 2993–3013. https://doi.org/10.1108/BFJ-05-2021-0498

Leek, S., Maddock, S., & Foxall, G. (2000). Situational determinants of fish consumption. *British food journal*, *102*(1), 18–39. https://doi.org/10.1108/00070700010310614

Lesur-Irichabeau, G., Guyader, O., Frésard, M., Leroy, C., Latouche, K., & Grel, L.L. (2016). Information on sellers and buyers characteristics: Added value to explain price formation at primary fish markets in managed French scallop fisheries. *Applied Economics*, *4*(22), 2078–2092. https://doi.org/10.1080/00036846.2015.1114576

Marette, S., Roosen, J., Blanchemanche, S., & Verger, P. (2008). The choice of fish species: An experiment measuring the impact of risk and benefit information. *Journal of Agricultural and Resource Economics*, *33*(1), 1–18. http://www.jstor.org/stable/41220610

Matuli, D., Tomi, M., & KOVAčIćEK, T. (2016). Attitudes as basis for segmenting Croatian fresh fish consumers. *Mediterranean Journal of Economics, Agriculture and Environment*, *15*(4), 63–71. https://www.proquest.com/scholarly-journals/attitudes-as-basis-segmenting-croatian-fresh-fish/docview/2458954301/se-2

Nonthapot, S., & Sompholkrang, M. (2018). *Supply chain management of freshwater natural fish to increase the value in the upper Northeastern of Thailand*, (Research report No.140302). Thailand Science Research and Innovation. [In Thai]

Rickertsen, K., Alfnes, F., Combris, P., Enderli, G., Issanchou, S., & Shogren, J. F. (2017). French consumers' attitudes and preferences toward wild and farmed fish. *Marine Resource Economics*, *32*(1), 59–81. https://doi.org/10.1086/689202

Singh, K., Dey, M. M., & Surathkal, P. (2014). Seasonal and spatial variations in demand for and elasticities of fish products in the United States: an analysis based on market-level scanner data. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, *62*(3), 343–363. https://doi.org/10.1111/cjag.12032

Srisakun, C., & Santiteerakul, A. (2015). Behavior of Consumers in Bangkok towards purchasing of canned fish. *AccBA Journal*, 1(3), 188–199. https://cmudc.library.cmu.ac.th/frontend/Info/item/dc:123762 [In Thai]

Witter, A., Murray, G., & Sumaila, U. R. (2021). Consumer seafood preferences related to alternative food networks and their value chains. *Marine Policy*, 131, 104694. https://doi.org/10.1016/j.marpol.2021.104694