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Is that a barramundi (*Lates calcarifer*) or a grouper (*Epinephelus* sp.)? Cross-country differences in species recognition in selected Southeast Asian Countries

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ABSTRACT

Seafood is a major source of protein in Southeast Asia (SEA). Consumers in SEA often purchase seafood in whole or live form from wet markets and traditional retail settings. In such contexts, visual recognition and prior sensory familiarity may shape food choice, trust and perceived product authenticity. This study aims to investigate consumers' ability to identify ten seafood species (including one freshwater fish). Ten species that are commercially sold and are widely available in the participating countries were used. Participants were shown standardised images of each species and asked to provide the commonly used name of the seafood species. A total of 1164 valid responses from Indonesia, Malaysia, the Philippines, Thailand and Vietnam were received. The participants scored an average of 4.94 ± 2.33 (median = 5.00) out of 10 species indicating average knowledge or familiarity with the seafood species. Cross-country differences were observed, with respondents from Malaysia (Odds Ratio [OR] = 9.092, $p < 0.001$) and Thailand (OR = 6.447, $p < 0.001$) demonstrating significantly higher identification accuracy. Living in coastal areas and more frequent seafood consumption were also associated with better recognition performance. These findings suggest that consumers' familiarity with seafood is influenced by cultural food practices, environmental proximity to marine resources and habitual consumption patterns. Our findings also revealed some common misconceptions of seafood species. The lack of familiarity of certain seafood species and no standardised acceptable or market names of seafood species may lead to misidenfication of seafood species. Variability in commonly used market or vernacular names further complicates consumer recognition and may influence perceived quality.

1. Introduction

Aquaculture and fisheries contribute 17% of global protein consumption (FAO, 2020) and are a major protein source in Southeast Asia (SEA), especially countries with long coastlines such as Indonesia, Malaysia and the Philippines. SEA countries contribute up to 22% (US $51 billion) of total global seafood production (Emam et al., 2021). However, seafood fraud is becoming prevalent in this region (FAO,

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2018). Seafood fraud occurs when 'seafood is deliberately placed on the market for financial gain with the intention of deceiving consumers (Spink et al., 2019). Common seafood fraud in SEA includes species substitution (i.e., a high value species is replaced by an inferior, lower value species such as grouper being substituted by Asian catfish) and undeclared product extension such as overglazing (i.e., adding layers of ice and disguising water weight as fish weight) (Fox et al., 2018). False or mislabelling of seafood is also a common fraudulent activity. Seafood mislabelling is where a product is intentionally labelled as a different species to deceive customers and the use of unacceptable or misleading market names (Ahles et al., 2025). For example, labelling haddock (*Melanogrammus aeglefinus*) or Alaskan pollock (*Gadus chalcogrammus*) as cod (*Gadus morhua*) (Brechon et al., 2016), tilapia (*Oreochromis nila*) as red snapper (*Lutjanus campechanus*) (Spencer and Bruno, 2019) and grouper fillet were substituted with barramundi (*Lates calcarifer)* (Panprommin and Manosri, 2022). In the US and Australia, the use of an unacceptable market name refers to the labelling of seafood species with an unapproved commercial name as documented in the FDA Seafood list (FDA, 2025) or Australian Fish Names Standards AS5300-2019 (AFNS) (Cundy et al., 2023). In the EU, both the commercial and scientific names must be present on the seafood product and that the commercial names are based on approved lists published by EU member countries (Regulation EU No. 1379/2013) (Mariani et al., 2015). Although intentionally mislabelling for economic gain is fraud, unintentionally mislabelling of seafood species may occur due to lack of knowledge and similar morphological appearances between species (Kitch et al., 2023). Seafood is highly vulnerable to fraud due to its similar appearance among many species, complex supply chains, wide price variation and fluctuations in supply, quality, and demand (Silva et al., 2021). An INTERPOL-Europol investigation of 57 countries revealed that fish was the third highest risk category of foods with potential for fraud (FAO, 2018).

Some of the major risks associated with seafood fraud include the introduction of potential contaminants and allergens into consumer diet that can lead to severe illness or death (Silva et al., 2021) For example, undeclared shellfish allergens due to substitution of fish with shellfish (Kitch et al., 2023) or the mislabelling of pufferfish (*Lagocephalus scleratus*), which contains the potentially lethal neurotoxin tetrodotoxin, as monkfish (Fox et al., 2018) can pose significant health risks to consumers. Seafood fraud compromises all 17 Sustainable Development Goals. It crowds out legitimate economic activity, destabilises food security and weakens food sustainability, undermines private sector contributions to economic growth and employment, and deprives government off revenues for investments in public services (Askew, 2019). Hence seafood fraud needs to be addressed to reduce the negative impact on consumer health, trade and illegal trading of endangered species.

Seafood substitution or mislabelling can be difficult to identify due to similarities in appearance, taste and texture between various species. This is particularly crucial for highly processed seafood products as one can't rely on morphological characteristics to differentiate between species. Thus, analytical methods such as DNA-based techniques are utilised by regulatory authorities and research for seafood authentication (Fernandes et al., 2021). However, the use of DNA forensic tools is limited to research institutions within our selected countries. This, combined with less progressive seafood regulations and traceability measures (Luque and Donlan, 2019), have contributed to seafood fraud in the region. The implementation of traceability policies faces significant challenges in this region due resource constraints, reliance on informal and small-scale fishing and trading practices and limited technological infrastructure (Yang et al., 2024). Practical and cost-effective strategies are required to tackle seafood fraud. One of such method is the ability to identify and distinguish between seafood species during purchase. This study holds significance value because unlike Western consumers, Southeast Asian consumers often prefer to buy whole, live or fresh fish from wet markets, supermarkets, restaurants or online (Budhathoki et al., 2022; FAO, 2015). Thus, consumers in these regions could rely on identification of external morphological characteristics as a practical and highly cost-effective approach to deterring seafood fraud.

Indonesia, Malaysia, the Philippines, Thailand and Vietnam were included in the study since these countries have long coastlines with strong preference for marine species (Dey et al., 2008). Annual fish consumption ranged between 12.8 and 55 kg per capita in these countries (Anyanwu et al., 2023; FAO, 2015; Kamaruddin et al., 2023). Consumers in these countries often fall victim to fraud due to incidents of seafood substitution and mislabelling throughout the supply chain. For example, in the Philippines, mislabelling of seafood products have been detected in market places (Maralit et al., 2013), street foods (Sarmiento et al., 2018) and even nationally accredited fishery exporting companies (Rey et al., 2023). Similarly, species substitution and various seafood fraud including illegal importation, illegal, unreported and unregulated fishing were reported in Indonesia (Abdullah and Rehbein, 2017; Owolabi and Olayinka, 2021) and Malaysia (Chin et al., 2016; Owolabi and Olayinka, 2021). A previous study on food fraud reported that consumers in Southeast Asia exhibited high level of concern about food fraud in the region (Soon-Sinclair et al., 2024).

Another reason on why this study should be conducted is that modern society has also become disconnected from the food sources and consumer knowledge of food production has decreased (Meyer et al., 2012). There is currently no empirical data pertaining to consumers' ability to identify local seafood in this region. Consumers who are well-versed in identifying seafood species (whole or live form) are less likely to be defrauded due to species substitution or mislabelling. Furthermore, the absence of such data prevents progress with respect to public understanding of seafood species and to standardise the commercial or acceptable market names in the country and/or region. The ability to identify seafood species is also a cost-effective approach to deter fraud. It is essential to understand the extent to which consumers are familiar with local, commercial seafood species. For these reasons, this study aims to investigate consumers' ability to identify local commercially available seafood species in selected Southeast Asian countries. Specifically, it seeks to answer the following research questions: (i) To what extent are consumers familiar with local and commercially available seafood species? (ii) What are the price differences between similar-looking seafood species? (iii) What are the implications on gastronomy and culinary practices?

2. Methodology

2.1. Seafood species

The following ten species that are available in the SEA countries were used: milkfish (*Chanos*), Indian scad (*Decapterus russelli*), Indian mackerel (*Rastrelliger kanagurta*), barramundi (*Lates calcarifer*), silver pomfret (*Pampus argenteus*), Japanese threadfin bream (*Nempiterus japonicus*), Nile tilapia (*Orechromis niloticus*), banana prawn (*Fenneropenaeus merguiensis*), whiteleg shrimp (*Litopenaeus vannamei*) and tiger prawn (*Penaeus monodon*) (FAO, 2015; FishBase, n.d.) (Fig. 1). *Oreochromis niloticus* is a freshwater fish, but the term 'seafood' was used to represent all fish and crustacean species in this study. These ten species are commercially and commonly available for sale in markets in the participating SEA countries (FAO, 2015; FishBase, n.d.). The seafood species, whether through aquaculture or fishery capture were also geographically available in the SEA region (FAO, 2025a,b).

2.2. Questionnaire development

An online questionnaire was developed and divided into two sections: (i) Demographics (12 questions) and (ii) Identification of seafood species (10 questions). In Section (ii), correct, incorrect, uncertain and blank answers were recorded. Incorrect, uncertain and blank responses

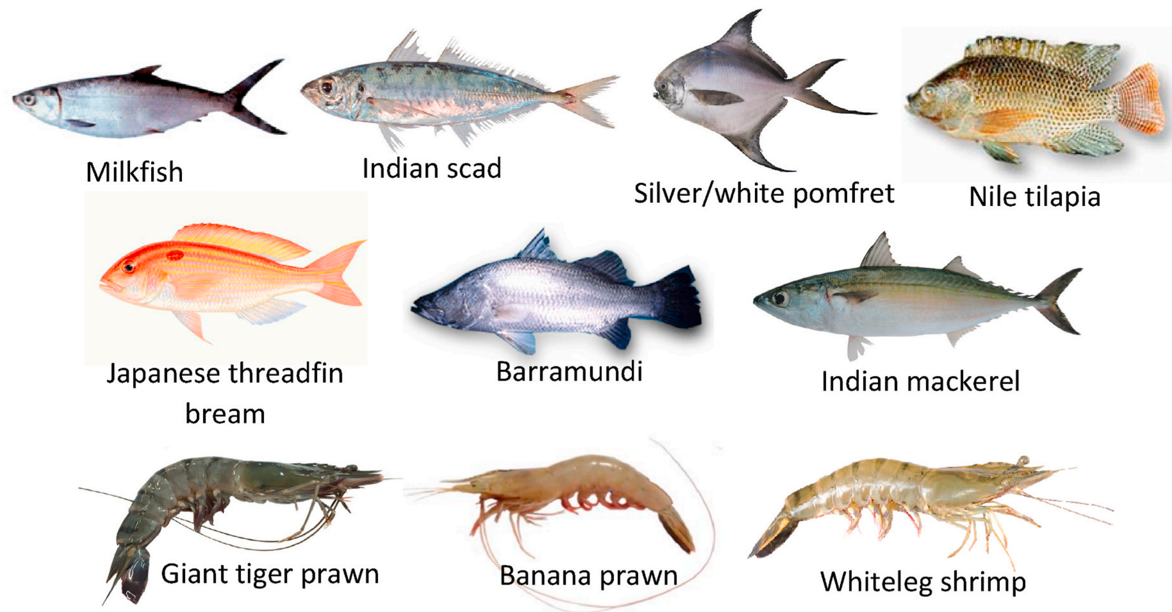

Fig. 1. Ten species of seafood commonly available in Southeast Asia (Image source: FAO, 2025a,b; FishBase, n.d.; FishIDER, 2023; Putra et al., 2020).

were given '0' point. For example, the vernacular names for *Chanos* (milkfish) are known as *bandeng, bolu or balanak sembawa* in Indonesia; *ikan bagas, susu or bangus* in Malaysia and *bagus, bangus* or *sabalo* in the Philippines; which are all accepted as correct responses. Respondents could list more than one vernacular name for each species. The online survey was translated into Bahasa Indonesia, Bahasa Malaysia, Filipino, Thai and Vietnamese. All surveys were reviewed by local food safety experts and back translated into English. The online questionnaires were uploaded onto onlinesurveys. ac.uk and pre-tested to ensure accuracy and suitable for mobile interfaces. The English version is available in Supplementary Material 1. All vernacular or local names of each country were cross-checked with www.fao.org/fishery/em/aqspecies (FAO, 2025a,b), www.fishbase.se (FishBase, n.d.), https://www.sealifebase.se (SeaLifeBase, n.d.), World Register of Marine Species (https://www.marinespecies.org/) (WoRMS, 2025) and www.talkaboutfish.com (TalkAboutFish, n.d.).

2.3. Recruitment

The online questionnaires were distributed widely using social media in each country and snowball sampling was used. The sampling approach encourages participants in their respective countries to share the survey with other participants to collect the responses. The eligibility criteria include 18 years or older, purchase and/or consume seafood and residents of the following countries: Indonesia, Malaysia, the Philippines, Thailand or Vietnam. The online survey was carried out between January – March 2025. Prior to completing the survey, participants were informed that the study was for research purposes and to explore if consumers were familiar with the local and/or commercial seafood species shown to them.

2.4. Statistical analyses

Chi-squared tests were used to determine the identification accuracy for each species between countries. Adjusted standardised residuals were used as post-hoc test to identify which country is significantly associated with correct responses for each seafood species. Ordinal Logistic Regression were used to test if the number of correct answers (0 to 10) from participants differed significantly between countries (Cusa et al., 2021) and other demographic factors such as gender, age group, whether they have lived in coastal areas, frequency of seafood consumption, etc. The number of correct answers were used as the dependent variable and all other demographic factors were independent variables.

Shannon diversity index – H, which measured the diversity of incorrect answers, was also calculated for all 10 species in each country using the following formula:

$$H = -\sum_{i=1}^{R} (p_i{*} \ln p_i)$$

where,

H = Shannon diversity index;

p_i = proportion of wrong answers given for ith species (number of times of specific incorrect ith species name was given/total number of all incorrect responses);

ln = natural logarithm.

R = Total number of species (10).

Higher H values indicate that respondents provided a wider range of alternative species names, suggesting greater uncertainty regarding species identity. Lower H values indicate that incorrect responses were concentrated on fewer alternative species names, where H = 0 indicates no diversity in incorrect responses. In our study, a low H value may also arise either because respondents correctly identified the species or because incorrect responses were concentrated on a limited number of alternative species names. Based on the incorrect responses given, the proportion for each incorrect response was calculated, and commonly misidentified species were identified. A pictorial and retail price comparison were conducted using Shopee.com, a widely used online platform in Southeast Asia to highlight the visual similarities, price differences, and potential for seafood mislabelling between correctly identified and misindentified species.

3. Results

A total of 1164 valid responses were received. Two-thirds of the respondents were female and more than 70% had not lived in coastal areas before. Slightly more than half of the participants were responsible for purchasing seafood for consumption. The most common place frequented by the participants were traditional or wet markets. Participants often relied on their own experience or information from sellers or relatives and friends to obtain information about the seafood they were purchasing. More than 70% of the participants cooked the seafood products themselves and up to 60% were frequent consumers of seafood ranging from once a week to daily consumption (Table 1).

The participants in the study identified correctly an average of 4.94 ± 2.33 (median = 5.00 and mode = 6.00) out of 10 species indicating average knowledge or familiarity with the seafood species. There were significant association ($p < 0.001$) between countries and whether the participants identified the seafood species correctly for all ten species (Table 2) (all of the chi square values are larger than critical value (critical value = 7.815, df = 3, at the 5% significance level). Additionally, Table 2 shows moderate to strong association between the countries and accuracy of seafood identification. Respondents from Indonesia and the Philippines were significantly more likely to identify milkfish correctly. The Philippines were also significantly more likely to correctly identify Nile tilapia compared to other SEA countries. Malaysia and Thailand respondents performed the best and demonstrated a significant positive association with correct identification for Indian mackerel, Japanese threadfin bream, silver pomfret, barramundi and giant tiger prawn. Thailand respondents were also significantly more likely to correctly identify banana prawn and whiteleg shrimp (Fig. 2).

Table 1
Demographics of participants from South East Asian countries (n = 1164).

Items	Frequencies (%)
Country	
Indonesia	220 (18.9)
Malaysia	236 (20.3)
Philippines	256 (22.0)
Thailand	298 (25.6)
Vietnam	154 (13.2)
Gender	
Male	394 (33.8)
Female	770 (66.2)
Age	
18 – 29	481 (41.3)
30 – 39	275 (23.6)
40 – 49	213 (18.3)
50 – 59	160 (13.7)
60 and above	35 (3.0)
Education	
Secondary	334 (28.7)
Tertiary	830 (71.3)
Employment	
Self-employed	122 (10.5)
Employed	566 (48.6)
Retired/Unemployed	75 (6.4)
Student	401 (34.5)
Residence	
Currently lives 100 km or less from nearest coast	529 (45.4)
Currently lives 100 km or more from nearest coast	635 (54.6)
Have you lived in coastal areas before?	
Yes	330 (28.4)
No	834 (71.6)
Are you the main person responsible for purchasing seafood?	
Yes	607 (52.1)
No	557 (47.9)
Where do you often purchase seafood from?	
Wet/traditional market	788 (67.7)
Supermarket	258 (22.2)
Street vendor	47 (4.0)
Fisherman	30 (2.6)
Farm	7 (0.6)
Others	34 (2.9)
Where do you obtain information about your seafood products from?	
Relatives and friends	250 (21.5)
Online platform including social media	123 (10.6)
Sellers	290 (24.9)
Own experience	473 (40.6)
Others	28 (2.4)
Do you cook your own seafood products?	
Yes	847 (72.8)
No	317 (27.2)
How frequent do you consume seafood?	
Everyday	63 (5.4)
4 or more times a week	137 (11.8)
1 – 3 times a week	495 (42.5)
1 – 3 times a month	335 (28.8)
Rarely	134 (11.5)

Table 2
Chi-square analysis for country seafood species identification.

Common names (scientific names)	Chi-square**	Cramer's V**
Milkfish (*Chanos*)	502.033	0.657
Nile Tilapia (*Orechromis tilapia*)	100.107	0.293
Indian mackerel (*Rastrelliger kanagurta*)	160.756	0.372
Japanese threadfin bream (*Nemipterus japonicus*)	378.171	0.570
Silver pomfret (*Pampus argenteus*)	298.087	0.506
Indian scad (*Decapterus russelli*)	191.763	0.406
Barramundi (*Lates calcarifer*)	307.845	0.514
Giant tiger prawn (*Penaeus monodon)*	195.650	0.410
Banana prawn (*Fenneropenaeus merguiensis*)	406.188	0.591
Whiteleg shrimp (*Litopenaeus vannamei*)	250.958	0.464

**$p < 0.001$, critical chi square value = 7.815, df = 3.

Table 3 shows the ordinal logistic regression predicting the number of correct answers in seafood species identification according to country and other demographic factors. The test of parallel lines were insignificant indicating that the proportional odds assumption was met in our model (chi-square test [χ^2 (135) = 90.786, $p > 0.05$]. The likelihood ratio chi-square test [χ^2 (15) = 307.814, $p < 0.001$] indicated a significant improvement in fit compared with the null (no predictors) model. The likelihood ratio chi-square tests were significant for the following variables: country, employment, whether respondents had lived in coastal areas before and frequency of seafood consumption.

There was an association between countries and the number of correct answers. Malaysia and Thailand showed higher odds ratios ranging from 4.300 to 13.523. All countries showed significantly higher odds of achieving higher number of correct responses on seafood identification compared to Vietnam, with Malaysia and Thailand showing strong positive associations. Those who had lived inland showed a negative association with an odds ratio of 0.513, implying that living inland is associated with lower identification scores. Those who were unemployed, retired or students (OR = 0.865) were less able to identify the seafood species correctly. In terms of seafood consumption, the odds of a respondent achieving a higher total score on seafood identification were 1.122 times greater for more frequent consumption.

The Shannon diversity index of incorrect responses in Table 4 reflects the diversity of participants' misconceptions about seafood species. A higher H value indicates a greater diversity of incorrect answers, while a value closer to zero indicates lower diversity in incorrect responses and potentially higher identification accuracy. Overall, seafood species with high correct identification rates generally exhibited lower Shannon diversity indices, reflecting fewer and less diverse misconceptions. Meanwhile, species with lower correct identification rates showed higher H values, indicating that respondents suggested a wider range of alternative species names. For example, respondents from the Philippines demonstrated the highest level of accuracy for milkfish and Nile tilapia, with little to no incorrect responses recorded (H = 0.00). In contrast, participants from Vietnam (H = 2.992) exhibited high Shannon diversity index for milkfish. Respondents from Vietnam listed up to 25 different variations over 59 times when attempting to identify milkfish. This high diversity of incorrect responses indicates that respondents from Vietnam used many different names (e.g., *Cá dìa* [tilapia], *Cá chép* [carp], *Cá mè dinh* [catfish], and *Cá vược* [seabass] when attempting to identify milkfish, suggesting greater uncertainty and lower familiarity with the species. This is attributable to the fact that milkfish is uncommon in Vietnam. Table 5 shows the comparison between the correct seafood species and examples of commonly misidentified species. For example, up to 21% responses from Malaysia identified milkfish as *ikan*

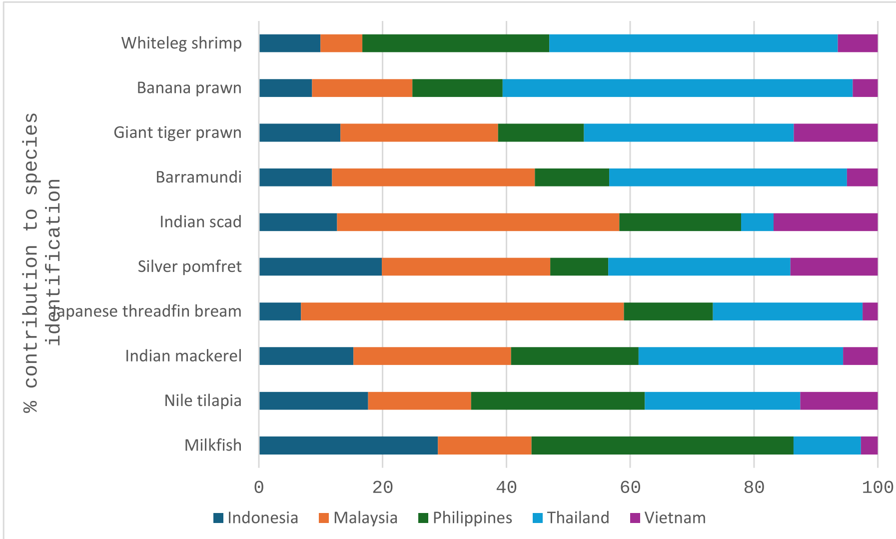

Fig. 2. Correct identification of seafood species according to country (%).

Table 3
Ordinal logistic regression predicting the number of correct answers in seafood species identification among respondents from five Southeast Asian countries.

Independent variables	B(SE)	Odds ratio (OR)	95% CI
Country			
Indonesia	0.662 (0.256)*	1.938	[1.173-3.203]
Malaysia	2.207 (0.203)**	9.092	[6.112-13.523]
Philippines	1.185 (0.207)**	3.269	[2.179-4.905]
Thailand	1.864 (0.207)**	6.447	[4.300-9.666]
Vietnam	0	1	
Gender	0.010 (0.116)	1.019	[0.804-1.269]
Age	−0.025 (0.060)	0.975	[0.867-1.096]
Education	0.190 (0.187)	1.209	[0.838-1.746]
Employment	−0.144 (0.068)*	0.866	[0.758-0.990]
Residence	−0.166 (0.113)	0.847	[0.679-1.056]
Lived inland	−0.667 (0.127)**	0.513	[0.400-0.659]
Responsible for purchasing groceries	−0.153 (0.119)	0.858	[0.679-1.083]
Place of purchase	−0.017 (0.051)	0.984	[0.890-1.087]
Information source	0.083 (0.045)	1.086	[0.996-1.186]
Responsible for cooking seafood	−0.171 (0.131)	0.843	[0.652-1.090]
Frequency of seafood consumption	0.114 (0.056)*	1.121	[1.004-1.251]

B = regression coefficient; SE = standard error; CI = confidence interval. Vietnam was used as the reference category for country. Positive coefficients and OR > 1 indicate higher odds of correctly identifying seafood species. *p < 0.05; **p < 0.001.

terubuk (shad) which is 1.75 times more expensive than milkfish (Table 5). In Indonesia, more than 70% of the responses misidentified Nile tilapia as *gurami* or gourami which is almost double the price of tilapia. Meanwhile, Vietnam respondents commonly misidentified Indian mackerel as *Cá nục* or Indian scad and 36.96% of responses incorrectly identified Japanese threadfin bream as *Cá hồng* (red snapper).

Table 4
Shannon diversity indices (H value[a]) of incorrect responses.

Seafood species	Indonesia	Malaysia	Philippines	Thailand	Vietnam
Milkfish	2.482	2.794	0	2.848	2.992
Nile tilapia	1.068	2.206	0	2.271	0.797
Indian mackerel	2.473	1.850	2.039	2.903	1.744
Japanese threadfin bream	2.337	2.810	2.040	1.828	1.808
Silver pomfret	2.867	1.264	2.353	2.693	2.369
Indian scad	2.917	2.235	2.472	2.618	2.493
Barramundi	2.932	2.098	2.615	2.077	2.734
Giant tiger prawn	0.981	1.343	1.751	2.221	1.981
Banana prawn	1.827	2.011	1.620	2.728	2.679
Whiteleg shrimp	2.488	2.426	1.547	2.497	2.726

[a] Note: Lower H values indicate that incorrect responses were concentrated on fewer alternative species names. It could also arise if more respondents identified the species correctly. Higher H values = greater diversity of incorrect responses suggesting greater uncertainty with species identity.

Silver pomfret was frequently misidentified as *ikan bawal mas* or pompano in Malaysia, while Indian scad was commonly mistaken for Indian mackerel across all countries. Barramundi was commonly mistaken as grouper in Indonesia, Malaysia, Thailand and Vietnam and as carp in the Philippines. More than 65% of responses from Indonesia and Malaysia incorrectly identified the giant tiger prawn as *udang galah* or giant freshwater prawn. Additionally, banana prawn and whiteleg shrimp were frequently misidentified or confused with each other.

4. Discussion

The majority of participants in selected countries purchased seafood products from traditional or wet markets. Seafood sold at these venues are often sold whole, fresh or even live sometimes. The fresh fish are often displayed on ceramic-tiled tables arranged in neat rows for easy selection (Solante-Catiwalaan and Funesto, 2025). Our study revealed that the participants sourced for fish information through their own purchasing experience. For example, this could be through experience of selecting, purchasing and preparing the seafood. According to Costa et al. (2024), consumers' choices are often driven by sensory expectations from previous experience and familiarity with common species. Sensory properties such as appearance, smell, and texture were linked to freshness and quality and were used as point of reference during

Table 5
Comparison of correctly identified seafood species and examples of commonly misidentified species.

Correct species	Examples of misidentified species
 a) Milkfis*Chanos chanosnos*) Retail price: US$4.00/kg	 b) Shad (*Tenualosa* sp.) *Retail price: US$7.00 – 7.80/kg
 c) Nile tilapia (*Oreochromis tilapia*) Retail price: US$ 1.50-2.80	 d) Gouram*Osphronemus goramyamy*) Retail price: US$2.80-5.20
 e) Indian mackere*Rastrelliger kanagurtarta*) Retail price: US$ 3.10/kg	 f) Indian sca*Decapterus russellilli*) Retail price: US$ 6.10/kg
 g) Japanese threadfin brea*Nemipterus japonicuscus*) Retail price: US$ 5.40/kg	 h) Snapper (*Lutjanus* sp.) Retail price: US$16.50/kg
 i) Silver pomfre*Pampus argenteuseus*) Retail price: US$ 5.00/kg	 j) Pompano (*Trachinotus* sp.) Retail price: US$ 5.90 (500 – 800 g)
 k) Barramun*Lates calcariferifer*) Retail price: US$ 17/kg fillet	 l) Grouper (*Epinephelus* sp.) Retail price: US$ 10-13/kg
 m) Giant tiger pra*Penaeus monodonodon*) Retail price: US$18.30/kg	 n) Giant freshwater pra*Macrobrachium rosenbergiirgii*) Retail price: US$20.10/kg

(*continued on next page*)

Table 5 (*continued*)

Correct species	Examples of misidentified species
 o) Banana pra*Fenneropenaeus merguiensisnsis*) Retail price: US$7.00-14.00/kg	 p) Whiteleg shri*Litopenaeus vannameiamei*) Retail price: US$4.70-10.60/kg

Retail prices were included to illustrate potential economic implications of species misidentification. Estimated retail price based on Malaysia's Shopee.com. Retail prices were in Ringgit Malaysia (MYR) and converted to US$. Image source: a-c; h, i, k, m-o: Tan, HC., Talkaboutfish (n.d.); d: Lin, JY. inaturalist (n.d.); e: Trevor, M. FishBase (n.d.); f, j, p: Hermosa Jr. G.V. FishBase (n.d.); g: Lai, NW. FishBase (n.d.); l: Randall, JE. FishBase (n.d.).

selection of seafood products. During purchasing, seafood selection may also be influenced by price fluctuations and species availability at the fresh counter (Carlucci et al., 2015).

Milkfish were identified correctly by most respondents from the Philippines and Indonesia as the species is considered the 'national' fish in the Philippines and is also one of the main aquacultured products in both countries (Komira, 2019; PCAARRD, n.d.). Nile tilapia is the second most cultured fish species in the Philippines making up to 20% of the total aquacultured production (SEAFDEC, 2020). However, the respondents from both countries performed poorer compared to other countries. It is likely that participants from Indonesia and the Philippines limited their seafood choices to familiar species such as their national fish and recipes and making it less likely to identify most species. Familiar species were also connected to positive sensory expectations and health benefits (Costa et al., 2024).

Malaysia and Thailand scored higher odds ratios in identifying the seafood species correctly compared to other SEA countries. Malaysia respondents were able to identify the highest number of species correctly. This could potentially be due to the local preference for seafood and the amount of fish consumed in the country. The annual fish consumption per capita in Malaysia is amongst the highest in the region, at 49 kg (FAO, 2024). On average, Malaysians consume 168 g fish/day and the most consumed fish was indian mackerel (Ahmad et al., 2016). Ahmad et al. (2016) also reported that other top marine species favoured by adults in Malaysia include pomfret, barramundi and threadfin bream. Thailand has a well-established aquaculture sector and is a main producer of brackish water species such as barramundi, giant tiger prawn, whiteleg shrimp and banana prawn (FAO, 2025a,b). This potentially explains the consumers' ability to identify the seafood species.

Employment significantly predicted the number of species identified. Students were less likely to identify a higher number of species, potentially due to lower familiarity with seafood. This may be attributed to their lower consumption frequency compared to older adults (Ahmad et al. 2016). Students or younger adults may be less involved in seafood purchasing and household food preparation which could further limit their exposure to different species. Those who had lived in coastal areas were more likely to identify higher number of species correctly. This is likely due to ease of access, availability and affordability of fresh seafood. Those who had lived in coastal areas may have had opportunities to work in the fishery industry thus aiding them to identify the seafood species. Previous studies had reported that geographic locations which affect availability and accessibility to seafood have a strong influence on seafood purchasing and consumption (Goczman et al., 2020; Zhang et al., 2021). Coastal communities may have a stronger connection to the area and have opportunities to work in the fishery industry, thus leading to greater appreciation and knowledge of different species. Those who consumed seafood more often were also able to identify a higher number of species correctly. Cusa et al. (2021) showed that consumers in Southern European countries with higher seafood consumption demonstrated better identification skills compared to Western Europe with a lower consumption rate. This suggests that exposure through regular consumption increases familiarity with different species and contributes to seafood identification abilities.

4.1. Consumer misidentification and implications for culinary practices

The identification patterns observed in this study suggest that visual similarity between species plays a central role in consumer misclassification. Several of the whole fish presented shared overlapping morphological features in terms of size, colour and body shape. Where perceptual cues are subtle, consumers may rely on heuristic categorisation (Torres-Peña et al., 2025) rather than species-level recognition. The Shannon diversity indices further highlighted recurring patterns of confusion, suggesting that certain species are cognitively grouped together by consumers. Such grouping may reflect habitual purchasing practices and marketplace presentation rather than taxonomic distinctions.

In culinary traditions across Indonesia, Malaysia, the Philippines, Thailand and Vietnam, seafood species are not interchangeable ingredients and are often embedded in specific recipes, cooking techniques, flavour pairings and cultural meanings (Ahmad et al., 2016; Narzary et al., 2021). Misidentification of species such as barramundi *(Lates calcarifer*) as grouper (*Epinephelus* sp.) or confusion between Indian mackerel (*Rastrelliger kanagurta*) and Indian scad (*Decapterus russelli*) may therefore alter not only economic value but also sensory and suitability for culinary preparations. For example, species such as Japanese threadfin bream (*Nemipterus japonicus*) are commonly used in surimi-based products and fish cakes due to their specific protein functionality and gel-forming capacity (Huda et al., 2001). Fraudulent substitution of banana prawn (*Fenneropenaeus merguiensis*) with whiteleg shrimp (*Litopenaeus vannamei*) may result in higher purchasing costs for the substituted product. Consumers and food businesses may be paying up to US$14.00 per kg when the lower retail price for the actual product was US$4.70 (See Table 5). This has implications not only for household cooking but also for street food vendors and small-scale food businesses that rely on visual cues when purchasing seafood.

In traditional retail environments, fish are commonly displayed whole and on ice, which could obscure subtle distinguishing features or where only parts of the fish might be visible. Under these conditions, consumers may also rely on common or vernacular names or sellers to inform them of the seafood species. In many Southeast Asian markets, vernacular names are widely used and vary across regions and languages. While this linguistic diversity reflects local food cultures, it may also introduce variability in how seafood species are recognised. When multiple species share similar market names, or when a single species is known by multiple names, consumers may experience uncertainty regarding product identity. Such ambiguity may influence perceived authenticity, quality expectations and purchasing confidence (Cusa et al., 2021). In an increasingly globalised culinary landscape where Southeast Asian cuisines are exported through tourism and sociall media

(Sharma and Wattana, 2024), clearer species identification may support the preservation of authentic flavour profiles and culinary heritage of the region.

International regulatory approaches provide contrasting models for naming practices. For example, under,(Regulation (EU) No. 1379/2013) seafood products must be labelled with both the common name and the scientific name (Do and Wong, 2025). In United States, vernacular names are for cross reference only and not acceptable for product labelling in interstate commerce. For example, the acceptable market name for *Lates calcarifer* is barramundi and the common name is giant perch. Vernacular names include palmer, cockup, bekti, nairfish, silver barramundi, asian seabass and koral are not acceptable as product labelling and may result in seafood misbranding (US FDA, 2025). In contrast only common name is required on food labels in Malaysia (Food Regulations, 1985 Regulation No 156-170 for Fish and Fish Products) (Chin et al., 2016; Food Act, 1983;Food Regulations, 1985). Differences in regulatory emphasis may shape how consumers learn and interpret seafood names over time. From a gastronomy perspective, clearer and more consistent naming conventions may function as informational cues that support seafood recognition and reduce cognitive load during purchase decisions. The Association for Southeast Asian Nations (ASEAN) could adopt the EU model by establishing seafood naming conventions to promote effective traceability of seafood and farmed species. Each country and region should define an 'acceptable market name' or 'commercial name' for seafood products, which can then be included in a harmonised regional list endorsed by ASEAN members.

Educational initiatives that integrate seafood identification into culinary training and education may therefore enhance both seafood literacy and culinary competence. Seafood literacy could be improved through educational or vocational programmes in schools that incorporate food preparation, cooking skills and nutrition studies. Besides formal education, social media influencers and culinary content creators may also play an important role in enhancing seafood literacy by demonstrating cooking techniques and recipes tailored to specific seafood species, while highlighting the morphological characteristics that can be used to distinguish them. Another practical strategy would be to improve seafood labelling by clearly displaying the correct or accepted market names alongside scientific names on whole seafood products and processed or packaged fillets. Since public or wet markets are often the primary point of contact between consumers and seafood products, educational posters or species identification charts that display commonly sold species could help consumers become more familiar with sefood diversity. Live seafood displays where customers could select fish or shellfish from tanks or water basins and then choose a cooking method are also quite common in the region. Thus, restaurants could facilitate seafood literacy by clearly labelling the acceptable market names and where feasible, scientific names. Such measures could increase consumer exposure to species information at the point of purchase and consumption.

Additionally, given the positive association between seafood literacy and seafood consumption, nutritional interventions aimed at increasing seafood consumption will not only improve public health outcomes but also enhance seafood literacy. This could be carried out through public health campaigns that promote healthy diets. Information about common seafood species and their nutritional value could be incorporated into existing community health and livelihood development programmes. While emerging DNA-based certification systems and voluntary seafood certification schemes have potential to enhance product transparency and consumer confidence (Palmisano et al., 2026; Zhang et al., 2026), their adoption remains limited in Southeast Asia (Lieng et al., 2018). Future research should therefore investigate consumers' awareness of and interest in seafood certification and traceability initiatives, as well as the opportunities and barriers faced by fisheries and aquaculture producers in implementing such systems. Understanding these factors may help inform the development of practical and feasible approaches to improving seafood authenticity and in the region.

4.2. Limitations

This study is not without its limitations. The study utilised non-probabilistic and snowball sampling approaches which limits the representativeness of the sample. It is likely that respondents who are interested in seafood topics were motivated to participate and share the online survey, thus contributing to selection bias. The number of respondents were less than 300 per country, thus the small sample size cannot be generalised to the population. As the study was conducted online, respondents may be able to search for the species names online using image searches to identify the species. However, we believe this is unlikely as the study was voluntarily and no incentives were provided. Additionally, the findings rely on self-reported responses which are subjected to recall bias. Due to the diversity of languages and dialects spoken in the region, there is a possibility that not all vernacular names were documented officially. The retail prices shown may vary depending on factors such as availability, seasonality, weather, consumer demand and currency exchange rates.

5. Conclusion

Consumers in SEA often purchase fresh seafood products from traditional or wet markets where products are sold whole or even live. The ability to identify the external morphological characteristics is a cost-effective way of ensuring seafood authenticity. The participants in our study scored an average of 4.94 ± 2.33 (median $= 5.00$) out of 10 species indicating average knowledge or familiarity with the seafood species. Overall, respondents from Malaysia and Thailand performed better in identifying the species correctly. Those who had lived in coastal areas and consumed seafood more frequently were also better at identifying the seafood species. Almost all respondents from the Philippines were able to identify milkfish correctly. Indian mackerel and indian scad were frequently misidentified as each other. Based on the Shannon diversity indices, our study also revealed some common misconceptions of seafood species such as confusing barramundi as grouper or carp. Among the selected countries, the sample from Vietnam had the lowest seafood identification scores, suggesting the great importance of consumer education programmes to improve seafood recognition in this country. Since inland consumers had a lower number of accurate responses in seafood identification, educational campaigns that aim to enhance their seafood identification skills should be implemented.

Implications for gastronomy

This study demonstrates that consumer ability to recognise seafood species is not only a regulatory or economic concern but a foundational component of gastronomic knowledge. In Southeast Asian countries, seafood forms a major component in main and complementary dishes. Species substitution or misidentification may reshape the sensory identity of these dishes. Gastronomic value is closely tied to perceived authenticity. In many Southeast Asian cuisines, specific species carry symbolic or celebratory value. Substituting a premium species such as grouper (*Epinephelus* sp.) with a lower-cost alternative may alter consumers' perceived prestige, trust and willingness to pay. The price differentials identified in this study illustrate how culinary value and market value intersect. Supports sustainable gastronomy. When consumers recognise a wider range of species, they may be more open to diversifying seafood choices. This could reduce pressure on over-exploited species and encourage the culinary integration of underutilised but locally abundant fish. From a gastronomy perspective, improving species literacy empowers consumers and food businesses to make informed decisions that preserve sensory integrity and cultural authenticity of seafood-based dishes.

Ethical statement

The study was conducted in line with the Declaration of Helsinki and received approval from the University of Lancashire (STEMH 1009). All participants were informed that the data collection would be anonymous, and participants could withdraw from the survey at any time without giving a reason. Online informed onsent was obtained.

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CRediT authorship contribution statement

Jan Mei Soon-Sinclair: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing. **Pornthipa Ongkunaruk:** Data curation, Formal analysis, Investigation, Writing – review & editing. **Mark Raguindin Limon:** Data curation, Investigation, Writing – review & editing. **Iwan Vanany:** Data curation, Investigation, Writing – review & editing. **Ikarastika Rahayu Abdul Wahab:** Data curation, Investigation, Writing – review & editing. **Ruhil Hayati Hamdan:** Data curation, Investigation, Validation, Writing – review & editing. **Cong Duan Dao:** Data curation, Investigation, Writing – review & editing. **Thanh Mai Ha:** Data curation, Formal analysis, Investigation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

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

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Appendix A. Supplementary data

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Data availability

Data will be made available on request.

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