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ORIGINAL PAPER

Consumers' perceptions of food fraud in selected Southeast Asian countries: a cross sectional study

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Abstract

Southeast Asia is projected to be the fourth largest economy in 2050, where agriculture and food are key sectors contributing to the regional's GDP. However, ensuring food safety and traceability remains a challenge in the region and this offers ripe opportunity for fraudsters to take advantage of the system. This study aims to provide an overview of consumers' concern about food fraud in selected countries in Southeast Asia. A cross-sectional online survey was implemented in Indonesia, Malaysia, the Philippines, Thailand, and Vietnam, yielding 1393 valid responses. Multiple Correspondence Analysis (MCA) was conducted first to reduce the large dataset containing nominal variables. After that, ordered logistic regression was performed to predict food fraud concern, with independent variables being dimensions derived from MCA, total knowledge and experience, and demographic characteristics. We found that respondents from Vietnam and Malaysia were significantly more worried about food fraud compared to other countries. Concerns about food fraud were influenced by increased demand for food fraud control, perceived risks of different types of food fraud, information sources from media and personal networks, information sources from credible organisations, and self-experience of food fraud. Practical and policy recommendations for the region were suggested. This is the first empirical study on consumers' concern about food fraud in Southeast Asia. The study embodies the UK Global Food Security and UN Sustainable Development Goal No. 2 ethos of providing the growing global population with access to safe food.

Keywords Consumers · Food fraud · Food safety · Information source · Risk · Trust

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1 Introduction

Food fraud is the intentional deception for economic gain using food (Robson et al., 2021; Spink et al., 2019a, b). Food fraud includes adulteration, counterfeit, diversion of products outside of intended markets, over-run (legitimate products made in excess of production agreement), simulation, tampering and theft (Spink & Moyer, 2011). Meanwhile, the EU Rapid Alert System for Food and Feed (RASFF) categorises its notifications for fraud into adulteration, substitution, tampering, counterfeit, simulation, mislabelling, illegal import and trade, improper or fraudulent health certificate, absence of certified analytical report or health certificate, expired health certificate and suspicion of fraud (Soon, 2020a). Given the wide range of activities categorised as food fraud, it represents global economic and public health concerns for governments, food industry and consumers. Factors that influence food fraud range from resource scarcity to inadequate governance and low probability of detection. Food fraud can occur anywhere in the food supply chain i.e., at pre-farm level in the raw materials (such as substituting genuine seeds with counterfeit seeds) (Herring & Kandlikar, 2009), in an ingredient (substituting meat and poultry with cheaper meat ingredients or fillers) (Lianou et al., 2021), as well as in the final product or in the food packaging (expiry date changes) (Bouzembrak et al., 2018), to catering services (e.g. substitution or misrepresentation of dishes) (Pardo and Jimenez, 2020).

Although it is difficult to quantify the impact on the whole food supply chain, it is estimated that the impact of food fraud on the food industry exceeds US$40 – 50 billion annually (PwC, 2016; Spielman, 2020). International scandals involving fraudulent food, drink and alcoholic products have been reported globally (Visciano & Schirone, 2021) including Southeast Asia. The Southeast region of Asia is home to more than 650 million people and is projected to be the fourth largest economy by 2050. In this region, agricultural and food manufacturing are some of the key sectors driving the regional GDP growth (Vinayak et al., 2014). Small and medium enterprises (SMEs) represent between 97-99% of the enterprise population in most Southeast Asian countries. The SME sector is dominated by micro enterprises, mostly in retail and agricultural activities (OECD, 2021). Hence, ensuring food safety and traceability remains a challenge in some countries. Based on Cressey (1973) and Wolfe and Hermanson (2004)'s fraud models, this background offers opportunity for fraudsters to take advantage of the system. Scientific reports of food fraud in the region had been documented including rice fraud in Thailand (Kongsri et al., 2021), meat species substitution in Malaysia (Chuah et al., 2016) and seafood substitution in various Southeast Asian countries (Abdullah & Rehbein, 2017; Panprommin & Manosri, 2022; Chin et al., 2016). Food fraud incidents were also captured in local media, such as adulterated alcohol (Llewellyn, 2018; Rahimi et al., 2021), forged documents and meat smuggling (Md Ariffin et al., 2021), adulterated honey and spices (Medenilla, 2022; Tuoi tre News, 2018) in the region. However, the true incidence of food fraud in the region remains unknown although Everstine and Kircher (2013) estimated that food fraud affects approximately 10% of all commercially sold food products. The trend or rate of food fraud incidents should be viewed with caution as the rates are influenced by number of samples tested, whether these samples were random or targeted and food categories (i.e., premium food) (Points & Manning, 2020).

Despite the occurrence of food fraud in Southeast Asia, little is known about how food fraud is viewed by consumers. Previous studies of consumer perceptions of food fraud had been conducted in Europe (Charlebois et al., 2016; Kendall et al., 2019a), Canada (Charlebois et al., 2017) and China (Kendall et al., 2018, b; Soon & Xin, 2020). Findings from Charlebois et al. (2016) suggested that consumers in Austria who distrust the food industry and regulators were more likely to use a device to self-authenticate or validate the products' country of origin. Meanwhile, Kendall et al. (2019a) revealed that although European consumers were concerned about food fraud, however, they did not perceive food fraud to be a significant risk to food safety. This differs from Chinese consumers who relied on coping strategies to protect themselves from food fraud (Soon & Xin, 2020). These coping strategies were reflected in Canada, where consumers who had experienced food fraud or were aware of the incidents believed that food fraud can only be mitigated by themselves rather than food regulators (Charlebois et al., 2017). A recent Eurobarometer was completed in 2020 on 'Food fit for the future' among the 27 member states in EU. Up to 61% were concerned about being misled about the true qualities of a food. One in four reported that they want to be as confident in food imported into the EU as food produced locally (Special Eurobarometer, 2020). Most studies had been conducted in the West and in China, with very little published research in the rest of the world.

Moreover, it is unclear whether consumers from different countries view food fraud differently and which factors shape their views. To address these gaps, this study aims to provide an overview of consumers' concern about food fraud in selected countries of Southeast Asia. With a survey sample taken from five countries including the Philippines, Indonesia, Thailand, Malaysia, and Vietnam, this first cross-country consumer study on food fraud can contribute to the existing literature. This study also addresses the call

by world-leading food fraud researchers on the urgent need for more data collection from around the world (Spink et al., 2019a, b) especially from developing countries (Gwenzi et al., 2023). The findings generated from this study will be useful for the food industry and food regulatory officials in this geographical region.

2 Methodology

A cross-sectional study was conducted in Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. Local consumers residing in the selected countries were invited to participate in the study. The questionnaire was developed based on food fraud (Charlebois et al. 2016, 2017) and food safety consumer studies (Bolek, 2020; Ha et al., 2019). It was divided into five sections (i) demographics (7 questions); (ii) perceived risks of food fraud (8 questions); (iii) trust in information sources (8 questions); (iv) trust in food system actors (8 questions); (iv) knowledge and experience (8 questions), and v) food fraud concern (dependent variable, 1 question). The questionnaire was translated into Bahasa Indonesia (Indonesian language), Bahasa Malaysia (Malay language), Filipino, Thai and Vietnamese and back translated into English. The questionnaire is available in Supplementary Materials 1. All questionnaires were reviewed by food safety experts (first, second and fourth authors) for content validity and pilot-tested among 25 respondents in Indonesia and Malaysia. The pilot test was conducted among university students recruited through convenience sampling. The Cronbach's alpha from the pilot-test was 0.825 (risks of food fraud / adulteration), 0.881 (information sources) and 0.851 (trust), all of which were above the 0.60 threshold indicating high level of internal consistency (Hair et al., 2009). Results from the pilot-test were not included in the final analysis.

2.1 Perceived risks of food fraud

This section provides an overview of consumers' perceptions and understanding of risks associated with adulterated foods or fraudulent activities. Food risk perception refers to individuals' subjective evaluation of food risk. Previous literature shows that consumers' amplified risk perception of a particular food resulted in their negative emotional interpretations of that food (e.g., concern and fear), which had an immediate impact on food choice (Grunert, 2005). Ha et al (2019) found that perceived risk of different hazards associated with vegetables predicted consumers' worries over vegetable safety. Based on previous studies, we argue that risk perception of different common fraudulent activities will be likely to form consumers' concern over food frauds at a whole. Risks of food fraud (8 items) were rated using Likert scale of 1 to 5, where 1 = "Not risky at all" and 5 = "Very risky". Examples of questions in this section were 'In your opinion, how risky are the following food fraud issues: i) Adding banned colourings to spices; (ii) Substituting meat with cheaper meat products; (iii) Selling counterfeit foods (e.g., fake branded foods), etc. These questions were included based on media reports of food fraud (The Straits Times, 2015; The Jakarta Post, 2013; Nguyen, 2018) and associated research such as meat species substitution (Chuah et al., 2016) and prevalence of spice fraud (Owolabi and Olayinka, 2021) in the region.

2.2 Trust in information sources and food system actors

Consumers rely on information provided by government, health authorities, food manufacturers and researchers (Le et al., 2020; Rupprecht et al., 2020). Previous studies had identified that different sources of information were valued differently by consumers. Consumers from developing countries were more likely to trust information sources from government authorities, independent, third-party institutes and family or peer connections (Soon, 2020b; Wu et al., 2021). Trust in information sources (8 items) were assessed using Likert scale of 1 (strongly disagree) to 5 (strongly agree). Examples of questions include: 'I trust information about food fraud if it's shown on: (i) Government websites; (ii) Scientific publications; (iii) Television, radio or online news, etc.

Food system actors are defined as those who supply food and/or assure its safety and quality (Tonkin et al., 2019; Wu et al., 2021). Studies have determined that different food system actors and their abilities in providing, managing, governing and communicating food issues influence public trust in food (Ha et al., 2019; Reiher et al., 2017; Tonkin et al., 2019). Trust in food system actors were measured using eight items. Examples of questions include: 'I trust that food regulatory agencies can ensure food products are safe'; 'I trust that food companies will not buy from sellers that sell fraudulent food', etc.

2.3 Knowledge and experience

Previous studies revealed that Chinese consumers who were aware of food fraud were more likely to adopt preventative or coping strategies to protect themselves against adulterated food (Kendall et al., 2018, 2019b; Soon and Xin, 2020; Yan & Su, 2019). In this way, it is reasonable to expect that knowledge would increase consumers' confidence in food fraud handling and this subsequently influences their concerns about food fraud. Thus, it is necessary to gauge the current state of knowledge among consumers in this study. Participants answered 'Yes', 'No' or 'Uncertain' in the knowledge section, which contains 6 items. Correct answers were scored as 1 while incorrect

and uncertain answers were scored 0. The score for all items were aggregated into a total score, ranging from 0 to 6, with a higher score indicating a higher level of knowledge. Experience was found to shape food perceptions (Doets & Kremer, 2016). We argue that experience with food fraud might increase consumers' awareness about food fraud, thereby affecting food fraud concerns. Two items were used to measure respondents' experiences of food fraud i.e., 'I have experienced food fraud' and 'My family members had experienced food fraud'. The answer 'no' was coded as 0 and 'yes' as 1 and 'uncertain' was coded as 2 for analysis.

2.4 Food fraud concern

Food fraud concern, the dependent variable was captured via one item, i.e., 'How do you feel about food fraud?'. Respondents were able to choose from a 5-point Likert scale where 1 = Not worried at all to 5 = Very worried.

The questionnaire was hosted on Online Survey (http://www.onlinesurvey.ac.uk) platform. Prior to completing the survey, participants were provided with an explanation of the study and online consent was obtained. The Ethics Committee at University of Central Lancashire approved the study (Ref: STEMH 1009). Participants were only able to answer the survey once as the platform is set to prevent multiple entries or participation from the same respondent. Food fraud definition and some common food fraud incidents in Southeast Asia were provided as examples. To avoid bias responses, none of the examples were used in the subsequent survey items. Participants were recruited using convenience and snowball sampling via social media networks.

Descriptive statistics, Mann-Whitney U test, Kruskall-Wallis H test, multiple correspondece analysis (MCA) and ordered logistic regression were conducted using IBM SPSS 28.0 (IBM, Chicago). MCA was explored using variable principal normalization method on 24 variables which measured 'Perceived risks of food fraud' (8 items), 'Trust in information sources' (8 items) and 'Trust in food system actors' (8 items). Knowledge and experience are not included in the MCA. No supplementary continuous variables were included. MCA is a multivariate exploratory method to explore interrelationships between multiple nominal or categorical variables. Similar to principal component analysis, MCA generates a set of factorial dimensions that summarise the associations between the nominal variables. Variables in MCA do not need to follow a normal distribution which makes MCA appropriate for categorical variables (Greenacre, 2007; Higuera-Mendieta et al., 2016). To define the number of dimensions to retain, the following criteria were used: (i) eigenvalues of > 1.00 (a measure of inertia or variance accounted for by a dimension); (ii) Cronbach's alpha score > 0.70; and (iii) two-dimensional diagram of data (which facilitates and allows for data interpretation) (Costa et al., 2013; Gifi, 1996; Hair et al., 2009). The retained dimensions were used as factors or independent variables to be used in logistic regression. Other independent variables are total knowledge, experience, demographic characteristics including country, gender, age, and education. Food fraud concern is the dependent variable. P value < 0.05 was considered statistically significant.

3 Results

A total of 1418 responses were received of which 1393 were valid after removing missing data and incomplete survey responses. The demographics of the participants are shown in Table 1. There was statistically significant difference between gender (U=205100.50, p<0.001), where females were more worried about food fraud (4.13±0.84) than males (3.92±0.97). Kruskal Wallis H test showed a statistically significant difference in concern about food fraud between countries, $\chi^2(4)=124.300$, p<0.001, (Table 1), where respondents from Vietnam and Malaysia were consistently more worried about food fraud than the remaining countries. Respondents from Indonesia were somewhat less worried compared to other regions. Table 2 reveals the mean ranks

Table 1 Demographics (n = 1393)

Items	Description	Frequency (%)
Country	Indonesia	575 (41.3)
	Philippines	125 (9)
	Thailand	22 (1.6)
	Vietnam	369 (26.5)
	Malaysia	302 (21.7)
Gender	Male	550 (39.5)
	Female	843 (60.5)
Age	18–29	627 (45.0)
	30–39	375 (26.9)
	40–49	274 (19.7)
	50–59	73 (5.2)
	60 and above	44 (3.2)
Education	Primary	10 (0.7)
	Secondary	82 (5.9)
	Tertiary	1301 (93.4)
		Mean rank
How do you feel about food fraud	Vietnam	854.89[a]
	Malaysia	746.80[b]
	Philippines	652.07[bc]
	Thailand	607.68[bc]
	Indonesia	582.71[c]

[abc]Superscript denotes significant difference at p < 0.05

Table 2 Perceived risks of food fraud (MeanRank; n = 1393)

Variables	Kruskal Wallis	Philippines	Indonesia	Thailand	Malaysia	Vietnam
	(χ^2)	Mean rank				
Adding banned colourings to spices	149.59**	423.94	738.21	704.93	599.99	804.21
Substituting meat with cheaper meat products	45.55	595.09	649.04	690.55	706.67	798.72
Substituting meat with meat products from diseased animals	28.17**	675.35	665.72	600.39	739.32	724.21
Diluting milk with water	96.51**	523.67	628.34	735.27	720.81	840.94
Selling counterfeit foods (e.g. fake branded foods)	55.46**	722.89	661.24	607.75	638.82	796.89
Selling fruits and vegetables with pesticides above the permitted level	74.79**	529.65	668.03	744.68	745.69	756.14
Selling food products that were stolen	21.16**	799.89	659.10	568.75	733.97	698.60
Selling expired food products that were re-labelled with new expiry dates[a]	11.39*	721.90	690.05	554.20	713.37	694.51

[a]Assessed using Likert scale of 1 to 5, where 1 = Not risky at all and 5 = Very risky

Significant difference at *p < 0.05 and **p < 0.001

between countries. Vietnam and Malsysia were consistently ranked the highest among the countries.

In MCA, four dimensions were retained (Table 3) accounting for 92.25% of the total variance. Discrimination measures are shown in Fig. 1. It is worth noting that for a better interpretation of the data, Fig. 1 presents the result of the two-dimension solution, rather than 4-dimension solution, since in multidimensional scaling solutions, it is easier to interpret two dimensions (Ayele et al., 2014). Figure 1 shows four distinct groups of variables. The most discriminant group were variables located in red circle. It is followed by three groups of variables in blue, green, and black circles. Relating the graphical visualisation with the above result on the retained dimensions, these four groups of variables correspond to the four dimensions retained. Dimension 1 was termed 'Increased demand for food fraud control', dimension 2 was 'Information sources from credible organisations', dimension 3 was 'Information sources from social media and personal networks' and dimension 4 represents 'Risks of different types of food fraud'.

All four dimensions were used as independent variables in the ordered logistic regression. Other independent variables included in the ordinal logistic regression were country, age, gender, education, total knowledge, self and family experiences of food fraud. The likelihood ratio chi square test [$\chi^2(14)=310.591$, $p<0.001$] indicated a significant improvement in fit compared with the null (no predictors) model. The likelihood ratio chi square tests were significant for all independent variables except gender, age, education, total knowledge and family's experience (Table 4).

Specific country effects were determined in the ordered logistic regression. Indonesia was significantly less concerned about food fraud compared to Malaysia (Malaysia is coded as the reference value) while Vietnam was significantly more worried about food fraud. Vietnamese respondents reported they were almost twice as likely to be concerned about food fraud compared to consumers in Malaysia. Negative values associated with Indonesia, the Philippines and Thailand indicated less concerns about food fraud issues. Self-experience (OR=0.817, $p<0.05$) significantly predicted the model. There was an inverse relationship between self-experience and food fraud concerns. It means that respondents who have previously experienced food fraud were less worried about food fraud issues, compared to those who have not experienced food fraud.

Increased demand for food fraud control (OR=711, $p<0.001$) and risks of different types of food fraud activities (OR=1.028, $p<0.05$) significantly predicted the model. Respondents expressing greater demand for food fraud control and perceived risks of different types of food fraud activities were more worried about food fraud. For example, respondents were 0.64-1.14 times more likely to be worried about food fraud for each increasing unit in demand for food fraud control and risks of different types of food fraud activities (Table 4). Most risks were consistently ranked as agreed or strongly agreed. Selling expired food products re-labelled with new expiry date (4.81±0.57), substituting meat products with meat from diseased animals (4.78±0.63), and selling fruits and vegetables with pesticides above the

Table 3 Cronbach's alpha of multiple correspondence analysis

Dimension	Cronbach's alpha	Eigen value	Inertia	% of variance
1	0.895	7.041	0.293	29.336
2	0.880	6.382	0.266	26.593
3	0.831	4.906	0.204	20.442
4	0.770	3.811	0.159	15.879
Total		22.140	0.922	92.250

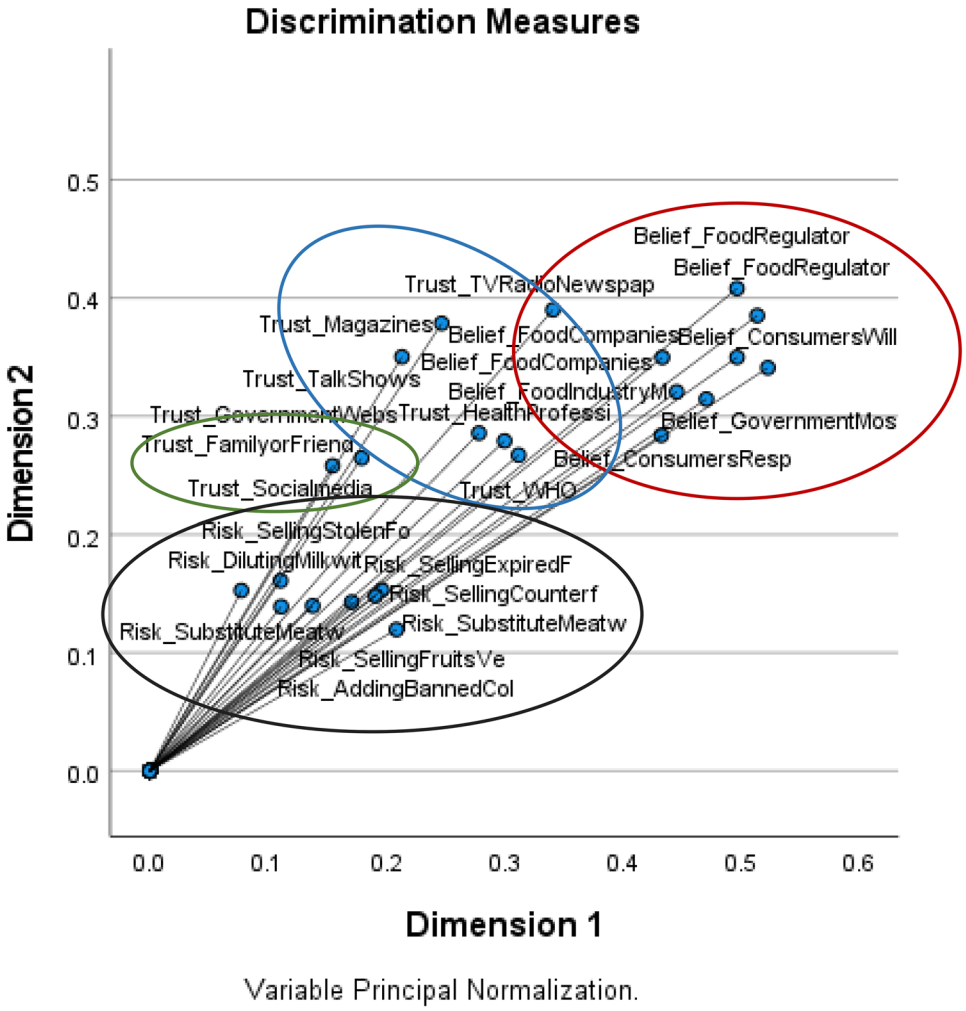

Fig. 1 MCA dimensions discrimination measures

Table 4 Ordered logistic regression predicting likelihood of consumers feeling worried about food fraud

Dependent variables	B(SE)	Odds Ratio	95% CI
Country			
Indonesia	-0.758 (0.141)**	0.469	[0.355–0.618]
Philippines	-0.142 (0.204)	0.867	[0.582–1.294]
Thailand	-0.349 (0.419)	0.706	[0.311–1.603]
Vietnam	0.773 (0.161)**	2.165	[1.579–2.969]
Malaysia	0	1	
Gender	0.108 (0.110)	1.114	[0.899–1.382]
Age	0.090 (0.054)	1.094	[0.985–1.215]
Education	-0.227 (0.190)	0.797	[0.549–1.156]
Total knowledge	-0.042 (0.047)	0.959	[0.874–1.052]
Self-experience	-0.203 (0.088)*	0.817	[0.688–0.970]
Family's experience	0.124 (0.092)	1.132	[0.945–1.355]
Increased demand for food fraud control	0.341 (0.055)**	0.711	[0.639–0.791]
Information sources from credible organisations	0.607 (0.055)**	1.835	[1.647–2.044]
Information sources from social media and personal networks	0.063 (0.054)*	0.939	[0.845–1.043]
Risks of different types of food fraud activities	0.027 (0.053)*	1.028	[0.927–1.139]

*$p < 0.05$; **$p < 0.001$

permitted levels (4.71±0.66) received strong agreement from most participants (Table 2). Information sources were identified as significant positive predictors. Respondents were 0.85 – 2.04 times more likely to be worried about food fraud issues for each increasing unit on trust of information sources (Table 2). For example, for each increasing unit on trust of information sources from credible organisations (where 1 = Strongly disagree and 5 = Strongly agree), respondents were 1.65 times more likely to be worried about food fraud.

4 Discussion

The present study confirmed previous findings about females being more concerned about food safety issues, such as those in India (Bailey et al. 2018), Vietnam (Pham & Turner, 2020), Malaysia and Indonesia (Soon et al., 2022). In Southeast Asian societies, females play a fundamental role in food production, purchasing and meal preparation. Most females in Indonesia (Chrisendo et al., 2020), Malaysia (Abdul Raji et al., 2017), Myanmar, Thailand, Vietnam and the Philippines (Akter et al., 2017) are responsible for households and food expenditures and cooking. Thus, their consideration for food security and safety issues are crucial to ensure adequate nutrition and safe choices for their family. Such consideration and responsibility might be a reason why their concerns about food fraud were higher than their male counterparts.

Self-experience was identified as a significant, but negative predictor of food fraud concern. As self-experience increased, concern about food fraud issues diminished. It is possible that consumers who had experienced food fraud first-hand were more likely to adopt risk mitigating strategies to protect themselves from food fraud. This potentially resulted in a lower likelihood of being a victim of food fraud later, thus reducing their food fraud concerns. For example, Soon & Xin (2020) revealed that Chinese consumers adopted three main risk mitigating strategies such as (i) purchasing fresh produce directly from farmers or small vendors; (ii) checking the integrity of food packaging and labels and (iii) growing or producing their own food to avoid food fraud. According to Charlebois et al. (2017), consumers who became victims of food fraud are more likely to gather information about the authenticity of food products. This helps to diminish their level of concern about food fraud.

Regarding country effect, previous studies have reported that consumers in Vietnam and Malaysia were highly concerned about food safety issues (Ha et al., 2019; Pham & Turner, 2020; Soon et al., 2022). Similarly, the present study revealed that both Vietnam and Malaysia were significantly more worried about food fraud issues compared to other countries. This study echoes other food safety studies as food fraud is known to affect the safety and quality of food products (Manning & Soon, 2016) and may cause serious food safety and public health implications. The reporting of various food safety and fraud issues in both countries may have elevated their concerns. Food fraud can be dangerous to health as evidenced by the use of illegal dyes in spices (Galvin-King et al., 2018), melamine in milk (Guan et al., 2009), methanol in alcoholic beverages (Rahimi et al., 2021) and seafood substitution resulting in food allergic reactions (Christiansen et al., 2018). Food fraud issues such as using artificial enhancement (e.g., urea) to preserve fish (Tran, 2013) and substituting local rice with imported grains (Vietnam Plus, 2021) had been reported in Vietnam. In Malaysia, multiple food fraud incidents had been reported, such as fake halal meat certifications (Md Ariffin et al., 2021), counterfeit beverages (The Straits Times, 2015), mislabelling of beverages in food services (Aisyah, 2020) and diluting fresh palm oil with recycled cooking oil (Lim et al., 2018).

The increase in demand for food fraud control was associated with greater concern about food fraud among respondents. This finding is unsurprising considering that consumers with higher level of concerns would demand for more control and/or monitoring of the food supply chain. There is assumption that if the current food fraud surveillance is already good, there would be no more demand for food fraud control. As such, consumers with a higher demand for food fraud control are those who disvalue the current food fraud control and have a higher level of pessimism in the food regulatory agencies and local food industry. This increases their concerns about food fraud. Such high level of pessimism might be influenced by the rise in reports of food fraud incidences in the region (Owolabi and Olayinka, 2021). There is a lack of a clear and globally agreed definition of food fraud (Robson et al., 2021; UK Parliament POST, 2020). Food fraud affects food safety, public health and/or quality (Manning & Soon, 2016). This makes it challenging for government authorities to address food fraud issues due to potential duplication and overlapping of ministries or departments' jurisdiction in addressing food fraud issues. It is also possible that the lack of law enforcement and coordination between various institutions responsible for food safety or food fraud makes it more difficult to implement food safety regulations. This is consistent with Nguyen-Viet et al. (2017) who suggested that the Ministry of Health, Ministry of Agriculture and Rural Development, and Ministry of Industry and Trade in Vietnam (these three ministries are responsible for food safety) should develop a better coordinated system for food safety management among the ministries. VietGAP (Vietnamese Good Agricultural Practices) was developed based on GlobalGAP and was introduced by the Government of Vietnam to facilitate food safety, but the uptake was low among farmers (Hoang, 2020) suggesting the need to understand the barriers to adoption of such systems. Enforcing food safety law is also a challenge in certain countries. For

example, the National Agency for Drug and Food Control (NADFC) in Indonesia struggles to enforce food safety law and relies on the police for law enforcement (Putri, 2018). However, the current efforts by Codex Alimentarius in drafting a new guidance on food fraud including clear definitions would assist member countries to understand the scale of the problem and address food fraud issues (MyGFSI, 2022; Taylor, 2022).

Perceived risks of different types of food fraud strongly predicted respondents' concern about food fraud. For example, pesticides in fruits and vegetables are a concern in Southeast Asia. Although the presence of pesticides could be due to accidental dosage, lack of knowledge or contamination, however, farmers tend to overuse pesticides in this region (Schreinemachers et al., 2020). FAIR (2020) and Zhang & Xue (2016) defined the addition of unapproved chemical additives and/or addition of chemical additives above the permitted level to artificially enhance the quality or other attributes of a product as artificial enhancement which is a type of fraud. Le & Nguyen (2018) revealed that farmers in Vietnam tend to produce two batches of vegetables: i.e., a safe batch for home consumption and an unsafe batch (where pesticides were above the permitted level) for sale. Consumers from Malaysia were also willing to pay more for safe, certified or organic vegetables (Joya et al., 2022). The present findings also revealed strong agreement among respondents on the risk of substituting meat with rotten meat or diseased animals. A number of raids where officials seized rotten meat products that were sold cheaper than regular market price had been conducted in the Philippines (ABS-CBN News, 2009), Indonesia (The Jakarta Post, 2013) and Vietnam (Saigon Online, 2012). The respondents in the present study were worried with the fraudulent act of selling expired food products that had been relabelled with new expiry dates. Owolabi and Olayinka (2021) had demonstrated that changes in expiry dates were prevalent in food products from Association of Southeast Asian Nations (ASEAN).

Trust in information sources were found to positively affect respondents' concerns of food fraud issues. Respondents reported higher level of trust on information from credible organisations such as World Health Organization (WHO), government websites, health professionals and news. This concurred with previous studies where scientists were one of the most trusted sources for scientific information (Liu et al., 2014; Soon, 2020b). Our findings revealed that respondents were concerned about food fraud issue if the incidents were reported by government authorities or World Health Organisation, as reports by credible organisations were often vetted or were under investigation prior to publication.

In April 2016, Vietnam Television launched a 'Say no to dirty food' programme to create awareness among the public on the dangers of unsafe food (Vietnam Plus, 2016). In Le et al. (2020), the researchers found that Vietnamese consumers place more trust on information provided by suppliers followed by government certification. Information from suppliers include labelling, place of production and store's reputation (Le et al., 2020). Food fraud issues are often hidden, and consumers cannot judge the products' safety, authenticity or quality. Thus, demand for food fraud control from food industry and regulatory is required. Consumers expect transparent information and/or guidance from regulatory officials and food supply chains that they are taking positive actions against food fraud (Frewer et al., 2002). Member states and food regulatory bodies in Southeast Asia could take advantage of the ASEAN Rapid Alert System for Food and Feed to exchange food safety information, including food fraud incidents (ARASFF, 2022). Notifications of incidents and measures taken to respond to the problems could help to ensure swift reaction by other member states following detection of the food safety and/or fraud incident (Manning & Soon, 2019).

Information sources from media and personal networks also significantly predicted concern for food fraud. Food fraud scandals had been shared via social media – some of which were fake news. This may have attributed to lower level of trust among the respondents.. Personal networks such as friends and family often share news or updates with each other. This is because Southeast Asia embraces collective cultures (Pelham et al., 2022). In this region, the culture of interdependence, obedience, maintaining harmonious relationships and hence family expectations play an integral part in daily life (Sumari et al., 2019). Thus, respondents in the present study were more likely to trust their family members or people close to them.

4.1 Limitations

This study used convenience and snowball sampling to recruit participants from selected countries. As online survey was administered, it is likely that the study had excluded potential participants with limited internet access. A high number of participants were also educated to university level and relatively young. The sample size is limited and significantly small; for example, there were only 22 respondents from Thailand and 125 from the Philippines. As such, research findings from this study were unable to generalise for the specific countries and region. The survey was based on self-reported practices, and it is likely that participants who were more engaged in food safety and food fraud topics were motivated to take part. This may have introduced selection bias among our respondents. It was challenging to recruit more participants despite the survey being made available in local languages.

4.2 Practical and policy implications

This study identifies a series of practical and policy recommendations. Food fraud is a concerning issue in Southeast Asian countries. Food fraud should be recognised as an old but emerging food safety and quality threat in national food safety systems, particularly for Vietnam and Malaysia where consumers' concerns about food fraud are highest. Since perceived risk of food frauds increased consumer concern, a better control of food frauds that are perceived as riskiest by consumers are needed to reduce consumer concerns and to enhance their trust in food. Monitoring expired food products, which have the highest risk perception should be a priority of food fraud policy. Although conventional methods of monitoring such as sampling and conducting food safety checks in food premises are important, the constrained enforcement resources in the region continue to pose a challenge. National food authorities could take advantage of local intelligence and cooperate with legitimate food industry to make the best use of combined intelligence and resources. For example, the National Food Crime Unit (NFCU) in the UK enables the public to report food fraud or suspicious food fraud issues safely (FSA, 2022). The combined efforts of public-private partnerships, intelligence and resources could deter potential fraudulent incidents. Since there is a high level of trust in information sources from credible organisations, there is a continuous need for ASEAN member states to share data on food fraud incidences, such as those initiated by the ASEAN Rapid Alert System for Food and Feed (ARASFF) (http://www.arasff.net). ARASFF is a platform that enables member states to notify and exchange information on direct or indirect risks associated with food and feed traded in ASEAN. The current data are available to ASEAN authorities in food safety and public health (ARASFF, 2022). In future, an open-access ARASFF consumers' portal could be incorporated to provide the latest information on food and feed safety risks. Such information will be valuable to small and medium food businesses that may have limited resources. This enables data transparency and ASEAN consumers to identify food and feed that has been flagged in the system (European Commission, 2022). A regional food fraud or food crime network could be established to support INTERPOL operations within the region. National and/or regional food fraud / crime units will be valuable in providing local intelligence and support to seize counterfeit and substandard food and drinks and dismantle organised food crime groups.

5 Conclusion

This is the first preliminary study to provide an overview of local consumers' concern about food fraud issues in selected Southeast Asian countries. A survey sample of about 1400 consumers was selected from Indonesia, the Philippines, Thailand, Vietnam, and Malaysia. The present findings revealed that respondents from Vietnam and Malaysia were consistently worried or very worried about food fraud. Selling expired food products that were re-labelled with new expiry dates, substituting meat products with meat from diseased animals and selling fruits and vegetables with pesticides above the permitted levels were identified as the riskiest types of food fraud activities. Country, self-experience, demand for food fraud control, risks of different types of food fraud and information sources were identified as significant predictors of concern about food fraud. Consumers' concern could be addressed by strengthening national and regional enforcement and coordination between various ministries and local authorities responsible for food safety. ASEAN RASFF could be utilised better and made open access to rapidly exchange information and notify member states of public health issues including food fraud incidents. ARASFF could tap into regional and national food safety expertise and resources to tackle organised food crime in the region. An understanding of consumers' perception and concerns about food fraud would assist responsible producers and manufactures' decision in technology investment to address food frauds. Further research on consumers' purchasing practices i.e., where do consumers predominantly purchase food from, their food preparation practices, and self-preservation techniques should be explored as these factors may affect consumers' risk perceptions. Our findings can help regulators and researchers to identify key areas of concern that could be targeted in efforts to improve food safety, quality and public health nationally, regionally and globally.

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Data availability Available on request.

Declarations

Conflict of interest The authors declared that they have no conflict of interest.

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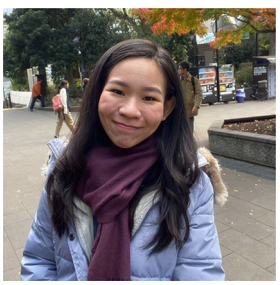

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