



Investigation on the understanding and implementation of food allergen management among Thai food manufacturers



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ABSTRACT

The understanding and implementation of food allergen management among HACCP-certified Thai food companies were surveyed during 2008–2009 by questionnaires and direct interviews with quality control managers of the companies. Forty of 72 respondents answered that they implemented a food allergen control program as part of existing product quality control and safety management. The awareness and understanding of food allergen management depended on the company's dominance in the market place as well as experience in food quality control and safety management. Although Thailand has no food allergen labeling legislation, the respondents expected that food allergen labeling legislation will soon be adopted in Thailand. Earlier implementation of labeling regulations has been driven by adherence to WTO (Codex) rules. The results of this survey indicated the substantial effectiveness of the present allergen control programs of Thai food manufacturers, and also their potential capability of food allergen management for domestic products at a level equal to that for export products.

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1. Introduction

Food allergy is defined as an adverse immune response of a sensitive person to food proteins (Sicherer & Sampson, 2006). Currently, food allergy is a significant and growing public health concern worldwide, affecting nearly 1% of the world's adult population (Ajala et al., 2010). The symptoms vary from mild to severe, and can occasionally be deadly serious (Reading, 2009). Because there is no medical cure for food allergy, the only way of preventing allergic reactions is strict avoidance of the hazardous allergic food (Vierk, Koehler, Fein, & Street, 2007). Any food has the potential to be allergenic, and in fact a large number have been reported to provoke allergic reactions. Among those, eight foods – peanuts, nuts, wheat, soy, eggs, milk, fish and shellfish – are widely used in food manufacturing, either as raw materials/ingredients or as food eaten by itself. These foods are reportedly responsible for causing more than 90% of allergic reactions in the USA (Bush & Hefle, 1996). Thus, a food that is nutritious for the majority of people might

represent an extreme hazard to someone with food allergy. In order to protect such allergic individuals, a food allergen labeling system, providing information on specific food allergen ingredients on the product label, has been adopted globally (Mills et al., 2004; Yamakawa et al., 2007).

Fundamentally, the enforcement of the practical food control regulation is essential to achieve successful food safety as it ensures the effective reaction and failure exclusion by the legal guarantee (Tähkääpää, Nevas, Kallioniemi, Korkeala, & Majjala, 2013). However, the control of food allergens is still not achieved even in countries which have enforced regulations related food allergy. The successful implementation to control the food allergen involves various factors, i.e. knowledge, attitude, practices and specific training received among the relevance persons (Choi & Rajagopal, 2013). Also, the efforts to reduce food hazard in places must consider active managerial control of risk factors in manufacturing (Wang et al., 2012). The risk factors are introduced as food products are improperly labeled, or contain a food allergen due to mismanagement e.g. overlooking the presence of an allergic ingredient (De Luis, Lavilla, Sánchez, Calvo, & Pérez, 2008); unintentional inclusion of a food allergen by cross-contamination during the food production process due to insufficient cleaning of

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shared equipment (Holzhauser & Vieths, 1999); and contamination through common facilities of production, such as a warehouse storing various raw materials for manufacturing (Hefle & Taylor, 2004). These undeclared food allergens in products pose a potential risk for allergic individuals. In fact, hospital emergency departments have reported severe allergic reactions caused by the accidental intake of food containing allergic materials (Wüthrich & Ballmer-Weber, 2001). Generally, the complete removal of allergenic ingredients from food products is not realistic (Crevel, 2005). Nevertheless, it is the responsibility of food manufacturers to continue their efforts to provide safe food for the consumer by establishing effective food allergen management practices: providing accurate allergen information on the product label, and preventing inadvertent cross-contamination of food allergens at all processing stages (Huggett & Hischenhuber, 1998).

In Thailand, food allergy is an unfamiliar concern; the majority of people are not aware of the problem, even though a significant number of studies have reported that food allergy exists in Thailand, similar to the situation in other countries (Poachanukoon & Paopairochanakorn, 2006; Santadusit, Atthapaisalsarudee, & Vichyanond, 2005). This indicates that food allergy is a latent public health hazard in Thailand.

Recently, we reported on the presence of undeclared food allergens in commercial Thai food products for local consumption. The results highlighted the potential health risks to Thai food-allergic individuals, and demonstrated the need for careful management of food production and labeling of food allergen information by Thai food manufacturers (Surojanametakul et al., 2012). Presently, food allergy-related information among Thai food manufacturers is lacking. Thus, a survey to assess the state of Thai food manufacturing is urgently required in order to ensure the potential capability of Thai food manufacturers to adjust to international food allergen management standards, as well as to ensure the safety of commercial food products. The present work is the first survey to focus on the understanding and implementation of food allergen management among Thai food manufacturers.

2. Methods

2.1. Selection of objective companies

The information presented in this report was collected via a field survey through questionnaires and direct interviews with food manufacturers during the years 2008–2009. Names and product categories of registered Thai food manufacturers certified as conforming to the Hazard Analysis and Critical Control Points (HACCP) management system were collected from a Thai company almanac and from the websites of all relevant Thai organizations, i.e. National Food Institute, Food and Drug Administration, and National Bureau of Agricultural Commodity and Food Standards of Thailand. A total of 121 food manufacturers, representing 14 primary food categories, were selected for the investigation.

2.2. Data collection

The questionnaire was composed of four parts: (1) general manufacturer profile; (2) production line characteristics; (3) food allergen control implementation; and (4) knowledge, understanding and concern regarding food allergen management. Questionnaires as well as further interviews were directed to the most knowledgeable person(s) responsible for quality control (QC), e.g. the QC manager, in order to assess the level of awareness, understanding and practices addressing food allergen management on-site.

2.3. Data analysis

Percentage responses are calculated based on the number of respondents answering the question. Depending on the questions, results are presented using descriptive statistics together with correlation analysis among parameters of company profiles, production line characteristics, understanding of food allergens, food allergen control procedures, and food allergen concerns.

3. Results

3.1. Food manufacturers profile information

From the total of 121 HACCP-certified food manufacturers, consisting of small-, medium- and large-size companies, 72 (59.5%) returned completed questionnaires. However, the responses were disproportionate: the majority of questionnaires were from large-size companies (51), followed by medium (17) and small (4) companies (Table 1). The 72 responding companies had varying experience with HACCP practices: up to 5 years (58.3%), 6–10 years (37.5%), and >10 years (4.2%). Although the HACCP system was first introduced in 1995, the Thai government has only recently begun to strongly promote HACCP in order to raise the level of Thai food manufacturing up to international standards.

Table 2 presents the number and percentage of food manufacturing companies by product category and company size. The 72 surveyed companies comprised 14 food categories, and some companies manufacture multiple food product categories; thus the sum of food manufacturers associated with all categories was larger ($n = 98$) than the total number of companies ($n = 72$).

Among 14 food categories, 5 categories – baby formula, snacks, frozen and ready-to-eat meals, meat, and hydrogenated and refined oils – were represented almost entirely by large-size companies (Table 2). This is probably due to the difficulty of small- and medium-size companies in competing with global enterprises in terms of efficient and economical production while maintaining quality. On the other hand, bakery products were produced only by medium-size companies; these products are not popularly consumed as a staple food among Thai people, and are products that are less technology-oriented, requiring freshness instead. Four food categories – beverages and soy milk, milk and dairy products, sauces and condiments, and premixed flour – were manufactured by companies of all sizes.

Among the products manufactured by the 72 companies, frozen and ready-to-eat meals were the most frequently found (14), followed by beverages and soy milk (13) and fishery products (12). These convenience food products currently are gaining in popularity among consumers because of the changing Thai lifestyle, and additionally are exported extensively with the encouragement of the government's "Thai Kitchen to the World" policy.

Cereal, frozen and ready-to-eat meals, fishery products, and beverages and soy milk, which are among Thailand's leading export products, occupied the majority of HACCP-certified companies due

Table 1
Number^a and percentage of HACCP-certified companies, by size.

Company size	Company	
	Number	Percentage (%)
Category 1 (small <10 employees)	4	5.6
Category 2 (medium 10–100 employees)	17	23.6
Category 3 (large >100 employees)	51	70.8
Total	72	100

^a Number of companies that answered the questionnaire.

Table 2
Food product categories and company size.

Food product category	Company size						Subtotal
	Category 1		Category 2		Category 3		
	(small)		(medium)		(large)		
	<10 employees		10–100 employees		>100 employees		
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	
Baby formula	0	0	0	0	1	100	1
Bakery products	0	0	2	100	0	0	2
Beverage and soy milk	1	7.7	5	38.5	7	53.8	13
Cereal	0	0	3	33.3	6	66.7	9
Confectionery	0	0	1	50.0	1	50.0	2
Fishery products	0	0	3	25.0	9	75.0	12
Frozen and ready-to-eat meals	0	0	1	7.1	13	92.9	14
Hydrogenated and refined oils	0	0	0	0	10	100.0	10
Meat	0	0	0	0	5	100.0	5
Milk and dairy products	1	20.0	1	20.0	3	60.0	5
Premixed flour	2	50.0	1	25.0	1	25.0	4
Processed fruits and vegetables	0	0	5	55.6	4	44.4	9
Sauces and condiments	1	25.0	2	50.0	1	25.0	4
Snacks	0	0	0	0	8	100.0	8
Total	5		24		69		98

to the strict quality control requirements of foreign customers. Forty-eight food manufacturers (66.7%) primarily distributed their products in the domestic market, and 24 (33.3%) overseas (Fig. 1). HACCP implementation has been widely accepted by Thai food manufacturers, especially among those whose products are primarily for the export market which is often subject to international food manufacturing standards. Currently, the top three export markets, i.e. the European Union, North America and Japan/Korea, represent 61.3% of the total export market, where food allergen labeling regulations are already enforced (Table 3). Accordingly, Australia and New Zealand have also begun enforcing food allergen labeling, so substantially 74.4% of the total export market requires food allergen management.

3.2. Production line characteristics

Production line characteristics can be categorized into three groups: dedicated line, shared line, and outsourcing. A dedicated line is designed to produce only one product in large volume, while a shared line produces more than one type of product. Outsourcing, on the other hand, is generally more suited for companies with small production volume or for new products, as it helps to reduce the initial investment risk, leading to easier start-up of production. In this survey, some companies manufactured a product category using multiple types of production line; therefore, the total number of lines was 120 (Table 4). Dedicated lines were the most common practice (54), followed by shared lines (52) and outsourcing (14); this probably reflects a preference for managing primary

production under their own production line. The frozen and ready-to-eat meal product category had the highest frequency of using a dedicated line, while fishery products used both dedicated and shared lines. Cereal, processed fruits and vegetables, and premixed flour products utilized outsourcing relatively frequently compared with other product categories. Because many of the ingredients used in such products – for example bakery products, e.g. premixed flour, chocolate, toppings, processed fruit (frozen fruit, puree), yeast, flavorings, fillings, baking enzymes, product enhancers/improvers – are supplied by overseas sources, this helps the company strengthen their core business process and reduce operating costs. According to the interviews, outsourcing was commonly employed to prepare the intermediate mixed ingredients for manufacturing the final product.

Forty-two of 72 (58.3%) companies had a reworking process to recover their defective products. However, the control of unformulated ingredients from the reworking process is hardly achievable. Consequently, reworking of identical products is primary conducted. In the management of the production line, 20 companies used a scheduled cleaning strategy to prevent food allergen cross-contamination. Of the 72 companies, 40 (55.6%) evaluated the allergen contamination risk in their production lines: low risk, 18 (25.0%); rather low risk, 10 (13.9%); medium risk, 8 (11.1%); rather high risk, 4 (5.6%); and high risk, 0 (0%); while 32 companies (44.4%) did not answer, perhaps suggesting a slight hesitation or unwillingness to answer (data not shown).

In the survey, the allergenic ingredients used in Thai food products were ranked (Fig. 2). The allergenic ingredients in food products from a total of 98 product categories (Table 2) were investigated, and five of these ingredients, i.e. wheat, rice,

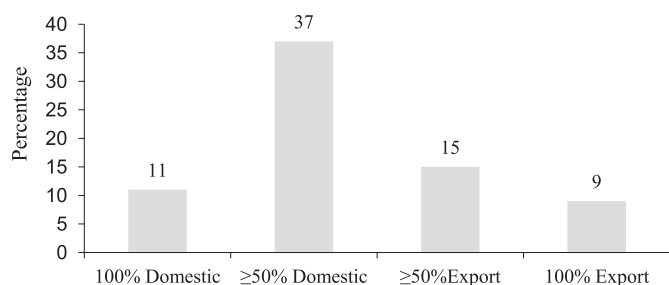


Fig. 1. Dominant market of surveyed companies.

Table 3
Overseas customers of Thai food manufacturers.

Country	Percentage (%)
European Union	23.8
North America	19.6
Japan/Korea	17.9
China	14.3
Australia/New Zealand	13.1
Other countries in Asia	11.3
Total	100

Table 4
Food product categories and production line characteristics.

Food product category	Production line characteristics						Subtotal
	Dedicate line		Shared line		Outsourcing		
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	
Baby formula	0	0.0	1	50.0	1	50.0	2
Bakery products	1	50.0	1	50.0	0	0.0	2
Beverage and soy milk	6	42.9	7	50.0	1	7.1	14
Cereal	5	45.4	4	36.4	2	18.2	11
Confectionery	1	25.0	2	50.0	1	25.0	4
Fishery products	7	46.7	7	46.7	1	6.6	15
Frozen and ready-to-eat meals	11	68.7	5	31.3	0	0.0	16
Hydrogenated and refined oils	6	60.0	4	40.0	0	0.0	10
Meat	2	25.0	5	62.5	1	12.5	8
Milk and dairy products	2	40.0	2	40.0	1	20.0	5
Premixed flour	2	33.3	2	33.3	2	33.3	6
Processed fruits and vegetables	6	50.0	4	33.3	2	16.7	12
Sauces and condiments	1	20.0	3	60.0	1	20.0	5
Snacks	4	40.0	5	50.0	1	10.0	10
Total	54		52		14		120

soybeans, eggs, and milk, represented the major allergenic ingredients (Fig. 2). Of these, wheat and rice were the most commonly used in Thai food products. Rice flour and rice starch, manufactured from Thailand's major crop, are popularly used as traditional food ingredients in Thailand because of dietary habits and inexpensive price. Although wheat, soybeans and their derivatives are imported, they are still widely used as main raw materials or ingredients in various kinds of food products due to their nutritional value and functional properties. Buckwheat, an emerging hazardous allergen (Sammut, Dennison, Venter, & Kurukulaarachy, 2011), is not yet commonly used in Thailand. Other potentially allergenic ingredients, including sesame, celery and mustard, are used occasionally.

3.3. Implementation of food allergen control in the production line

The increasing prevalence of food allergies in recent years has led food manufacturers to be more proactive in their responsibility for preventing any contamination by implementing effective allergen control programs (Chang, Sreedharan, & Schneider, 2013). In our survey, the companies' allergen control programs (ACPs; documented plans to address the management of allergenic ingredients) or specific activities concerning food allergen control were evaluated. From 72 respondents, 40 manufacturers (55.6%) reported implementing food allergen control as part of the quality

management platform of HACCP, Good Manufacturing Practices (GMP) or British Retail Consortium (BRC) programs. Practical control activities are shown in Table 5.

Around 77.5–85.0% of 40 manufacturers had instituted programs for seven of the nine control activities: purchasing, receiving and storage, inspection of raw material, food formulation, packing, cleaning and labeling processes. A comparatively low percentage (57.5–60.0%) of the companies applied the other two activities, i.e. process validation and finished product inspection, usually upon special request from the customer.

ACPs were most frequently applied (34/40 manufacturers, 85.0%) in the purchasing process and cleaning program (Table 5). Purchased materials are usually examined for allergenic information on the submitted material specification sheet. Moreover, data from the survey demonstrated that among the cleaning programs, visual checking of the production line was conducted mainly 70.6%, while practical checking with reagents was conducted in 29.4%. According to QC manager interviews, the cleaning program was performed as part of general sanitation practices, but not specifically for food allergen control. Food allergen control activities for purchasing, receiving and storage, inspection of raw materials, food formulation, cleaning, and labeling processes were usually conducted by examining the submitted documents and process results. Process validation and finished product inspection were conducted less frequently because they requiring special resources, i.e. knowledgeable experts as well as special reagents/equipment. Inspections for food allergen control were occasionally performed by protein detection test, Adenosine triphosphate (ATP) test, and allergen-specific enzyme-linked immunosorbent assay (ELISA).

Table 6 presents the correlation between export regions and the adoption of a food allergen control program by Thai food manufacturers. The results revealed that an average of 64.3% of food exporters conducted ACPs. Manufacturers exporting products to Japan and Korea had a higher percentage of ACP application, probably due to the enforcement of strict allergen labeling regulations in Japan. In addition, the relatively high frequency of ACP application among companies exporting to other Asian countries, e.g. Malaysia and Singapore, was also notable as these two countries serve as hubs for processing and forwarding food products to the EU, Japan/Korea, North America and Australia/New Zealand. Companies that exported products to Australia/New Zealand and China showed a relatively lower frequency of applying ACPs.

Product labeling is of great interest for food-allergic consumers because it allows them to obtain critical food allergen information.

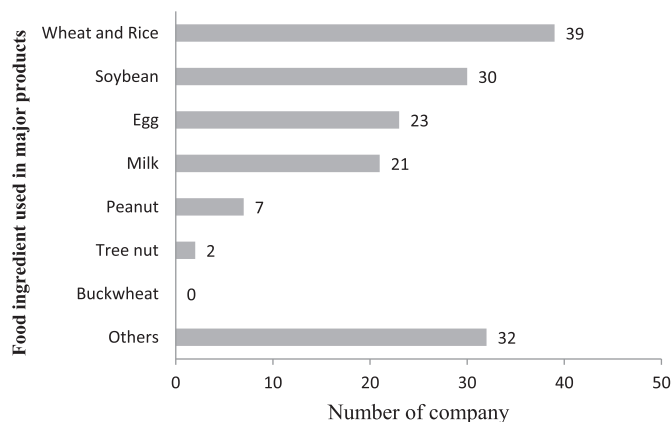


Fig. 2. Food allergen ingredient used in Thai food products ($n = 154$).

Table 5

Activities related to food allergen control among 40 food manufacturers.

Control activity	Food allergen management				Total	
	Applied		None		Number	Percentage (%)
	Number	Percentage (%)	Number	Percentage (%)		
Purchasing	34	85.0	6	15.0	40	100
Receiving and storage	33	82.5	7	17.5	40	100
Inspection of raw material	31	77.5	9	22.5	40	100
Food formulating	34	85.0	6	15.0	40	100
Process validation	23	57.5	17	42.5	40	100
Inspection of finished products	24	60.0	16	40.0	40	100
Packing	31	77.5	9	22.5	40	100
Cleaning	34	85.0	6	15.0	40	100
Labeling	29	72.5	11	27.5	40	100

Table 7 shows the labeling information provided for food products from 72 Thai manufacturers. Companies provided food allergen information more frequently for export products than for domestic products because of the lack of food allergen labeling laws in Thailand.

In regard to domestic product labeling, certain grocery chains voluntarily agreed to begin food allergen labeling of their products in response to requests from Thai consumers. The specific food allergen statements were the same as those commonly used for items exported abroad: either “Contains [allergen]” (4.2%) or “May contain allergen” (2.7%). The statement with the highest prevalence (16.7%), “Ingredients declaration”, does not specifically refer to food allergen content, but is a declaration of the ingredients according to food laws. This labeling concept is not suitable for food allergens, which can be hazardous to health even in minute quantities. On the other hand, a much higher percentage of products for overseas markets contained food allergen information because of labeling requirements abroad. The most commonly used statement was “Contains [allergen]” (34.7%), followed by “May contain allergen” (9.7%) and “Ingredients declaration” (9.7%). Other statements such as “Produced in a facility/equipment that also processes allergen” were rare.

3.4. Understanding of food allergen management and labeling

Results of interviews with quality control managers regarding self-evaluation of food allergen management and understanding of labeling regulations are presented in Fig. 3 and Table 8.

The majority of QC managers (70.8%) had medium to good understanding of food allergen management. The level of understanding was mostly related to their experience in food safety, more specifically in their engagement with food allergen management. Additionally, QC managers of companies with a higher proportion of exports had significantly higher scores of understanding ($p < 0.05$) (Table 8).

Table 6

Export regions and the application of food allergen control programs.

Export region	Food allergen control program				Subtotal	
	Applied ^a		None		Number	Percentage (%)
	Number	Percentage (%)	Number	Percentage (%)		
European Union	26	63.4	15	36.6	41	100
Japan/Korea	25	75.8	8	24.2	33	100
North America	19	63.3	11	36.7	30	100
China	13	56.5	10	43.5	23	100
Australia/New Zealand	12	57.1	9	42.9	21	100
Other county in Asia	13	65.0	7	35.0	20	100
Subtotal	108	64.3	60	35.7	168	100

^a Applied ACP following the HACCP, BRC or GMP system.

Table 7

Allergen-related labeling practices.

Market	Prevalence of use of specific allergen statements (%)				
	None	“Contain [allergen]”	“May contain allergen”	Ingredients declaration	“Produced in facility/equipment processing allergen”
Export	44.4	34.7	9.7	9.7	1.5
Domestic	76.4	4.2	2.7	16.7	–

Food allergen labeling provided benefits for manufacturers, especially those whose major product is for export. The greatest benefit was to increase the product's reliability in foreign markets where food allergen labeling regulations are enforced. On the other hand, the responses of companies whose major market is domestic indicated comparatively fewer benefits of labeling (Table 9).

The “Codex Alimentarius” is a set of internationally recognized standards and guidelines relating to food production and food safety recognized by the World Trade Organization (WTO). In our survey, the factors “Facilitate food exporting activity” and “Driving force from WTO (Codex)” were regarded as stronger influences on enforcement of food allergen labeling regulations than “Safety of food-allergic consumers” (Table 10); this indicated that the manufacturers are more concerned with the business aspect of product labeling, while their awareness of the problem of food allergies is still limited. Meanwhile, 94.4% of the manufacturers expected that food allergen labeling would soon be enforced in Thailand (Table 11).

4. Discussion

Food allergy has a significant impact on human health. A recent study in Thailand confirmed that the fatal allergic human reaction, anaphylaxis, occurred principally due to food allergy as opposed to

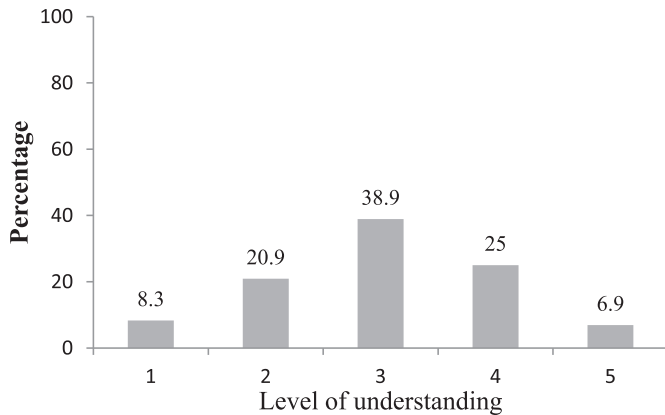


Fig. 3. Quality control managers' self-rated understanding of food allergen management. Score range from 1 to 5, where 1 = low understanding and 5 = high understanding.

other allergies (Piromrat, Chinratapisit, & Trathong, 2008). Since there is no proven medical cure for food allergy, food-allergic individuals must be very careful about their diet, i.e. avoid hazardous food allergens. Consequently, a product label that conveys food allergen-specific information is very important for allergic consumers to select safe food. Hence, many countries have already adopted food allergen labeling regulations. Thailand, however, has not, and so there is no legal requirement for Thai domestic products to contain information about food allergens on the label. Even HACCP-certified food manufacturers in Thailand demonstrate limited food allergen management. It is easy to imagine that much smaller-sized food companies supplying items for local consumption might manufacture under conditions of no or poor food allergen management. In fact, a recent report on commercial Thai food products revealed the existence of undeclared food allergens in the products, which shows the high potential health risks that could occur from food allergy (Surojanametaku et al., 2012).

Presently, food allergen labeling is totally dependent on the voluntary participation of the food manufacturer in Thailand. The problem with voluntary labeling is that when a product is not labeled for food allergens, the consumer is unable to distinguish whether the product does not contain food allergens because it was manufactured under food allergen management conditions, or whether the product was produced by a manufacturer who has not yet implemented a food allergen management program. Meanwhile, the awareness of food allergy among Thai food manufacturers has increased significantly due to the WTO's advocacy of the "Codex General Standard for the Labeling of Prepackaged Foods" (Jongwanich, 2009). The government's "Thai Kitchen to the World" policy, which aims to promote the export of Thai food products globally, automatically requires the management and labeling of food allergens according to Codex guidelines.

Table 8

Understanding of food allergen labeling regulations relevant to the market.

Market	Score of understanding
100% Domestic	2.4 ^a
>50% Domestic	2.8 ^a
>50% Export	3.3 ^{ab}
100% Export	3.9 ^b

Scores followed by different letters indicate a significant difference ($p < 0.05$).

Score range from 1 to 5, where 1 = low understanding and 5 = high understanding.

Table 9

Benefits of food allergen labeling for food manufacturers.

Benefit	Score of food product	
	Export	Domestic
Information for food-allergic individuals	4.3	3.7
Increased product reliability	4.9	4.3
Decrease cross-contamination of food allergens in the product	4.2	3.8

Score range from 1 to 5, where 1 = low benefit and 5 = high benefit.

Table 10

Factors influencing enforcement of food allergen labeling regulations in Thailand.

Factor	Impact level
Driving force from WTO (Codex)	4.2
Facilitate food exporting activity	4.2
Safety of food-allergic consumers	3.7

Score range from 1 to 5, where 1 = very low impact and 5 = very high impact.

Consequently, many Thai food exporters instituted such rules directly, and began conducting food allergen management and labeling so their products were in keeping with international trade requirements. Practically, it helps to avoid a product recall or an allergenic hazard in Thai food products, thus preventing serious damage to the reputation of Thai food products. Some of the manufacturers surveyed in this study were found to use double labeling for the identical product, i.e. labeled for export declaring food allergens, and for domestic consumption without declaring food allergens. In order to protect Thai food-allergic individuals, the introduction of national regulations for food allergen labeling and management is keenly anticipated.

The food allergen labeling statements on products for both export and domestic markets (Table 7) – i.e. "Contains [allergen]", "May contain allergen" and "Produced in a facility/equipment that also processes allergen" – are commonly used in countries where food allergen labeling regulations are enforced. Among these, "Contains [allergen]" was the most commonly used. It should be noted that the statement "Contains [allergen]" is likely to denote the intentional addition of allergenic ingredients, but is less likely to mean cross-contamination (Taylor et al., 2006). Meanwhile, statements such as "May contain allergen" and "Produced in a facility/equipment that also processes allergen" commonly denote the unintentional incorporation of a food allergen, such as by the use of shared equipment with insufficient clean-up, or by the use of ingredients that cannot exclude the possibility of adventitious cross-contamination or carry-over (Taylor et al., 2006). "Produced in a facility/equipment that also processes allergen" is acceptable according to Japanese labeling regulations, as it provides information for food-allergic individuals who have a certain allowable intake of a food allergen without experiencing a severe allergic reaction, and thus increases the number of food products that food-allergic individuals can eat, depending on their level of allergic reaction.

Table 11

Expectations of food companies regarding food allergen labeling enforcement in Thailand.

Expect on food allergen labeling enforcement	Food companies	
	Number	Percentage (%)
Yes	68	94.4
No	4	5.6
Total	72	100

In our survey, the main factors influencing the enforcement of food allergen regulations in Thailand were the driving force from WTO (Codex) standards and the facilitation of food exporting activity (Table 10). Thailand is a major exporter of food products, and the Thai government strongly promotes food exports as well. Accordingly, the WTO (Codex) international food standards are very important for ensuring standardized practices in the food trade to protect consumer health. The Thai government is planning to adopt such quality and safety regulations to improve the performance and competitiveness of Thai food products in the global market.

The interviews with QC managers revealed that larger-sized companies have more opportunity to export their products under the international trade framework, and also were exposed to greater public scrutiny; therefore, they have stricter quality management systems (i.e. the HACCP program, requiring enlightenment and education about food safety as well as food allergen management) than smaller-sized companies.

None of the QC managers felt that their products had a high risk of allergen contamination when produced by their own manufacturing lines. However, 12/72 (16.7%) companies recognized a medium to somewhat high risk level of allergen cross-contamination in their products, which could possibly occur by the unintentional inclusion of a food allergen through the food ingredient supply chain (Monaci & Visconti, 2010); this implied that nationwide food allergen management is needed in Thailand.

Most manufacturers used dedicated and/or shared lines for their production, while comparatively few used outsourcing. Frozen and ready-to-eat meals was the category with the highest percentage (68.7%) of using a dedicated line, followed by hydrogenated and refined oils, and processed fruits and vegetables. Shared lines were also widely used (43.3%) in order to achieve the most efficient use of the production facility. The best-practice management for food allergens is to use a dedicated line in order to avoid cross-contamination. However, it is not easy to establish a dedicated line when the volume of production is small. Accordingly, the shared line practice of separating the production using an allergic ingredient from that not using an allergic ingredient is already conducted in many small- and medium-sized companies, based on internationally recognized safety assurance systems such as HACCP. Consequently, Thai food products have not experienced any serious food allergy-related incidents.

5. Conclusions

Our report is the first survey on the understanding and practices of Thai food manufacturers concerning food allergens. The majority of HACCP-certified food manufacturers (63/72, or 87.5%) distributed their food products primarily in the domestic market. Among these, 52/63 (82.5%) also exported their products, indicating that the overseas market is also significant. Therefore, a substantial number of the food manufacturers surveyed have already implemented food allergen management practices at an international food safety level. They demonstrated a very high awareness of food allergy as well as the management and labeling of food allergens, and expected that food allergen labeling regulations would soon be enforced in Thailand. The result presented that active managerial control of food allergen in HACCP-certified companies has been substantially practiced by extending the existing HACCP system, and will encourage the food companies which have no food allergen practice to prepare for the global trend of food allergen labeling regulation and guide the maximum use of present quality control system. Fortunately our survey indicated the potential

capability of Thai food manufacturers to adopt the upcoming food allergen regulations.

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