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# 1 Food allergen labelling: "May contain" evidence from Malaysia

## 2 3 **Abstract**

4 Food allergen labelling is mandatory and regulated whilst precautionary allergen labelling (PAL)  
5 remains voluntary in most countries. It is the aim of this study to identify the food allergens declared  
6 in food products sold in a developing country and to what extent food allergens and PAL are  
7 emphasised in the products. A total of 505 food and beverages (snacks, baked goods, confectionary,  
8 baby food, condiments & jams, beverages, powder & paste, instant food, chilled & frozen food and  
9 canned food) were evaluated in Malaysia. Soybean represents the largest group of food allergen  
10 declared in labels, followed by wheat and milk products. Thirteen variations of contains statement  
11 were found with 'Contains [allergen(s)]' being the most common (55.02%). There were 22 different  
12 types of 'may contain' statements with 'May contain traces of [allergen(s)]' being the most common  
13 advice labelling used (55.41%). Different font type or emphasis such as brackets (51.57%) and bold  
14 font (33.86%) were used to inform consumers about presence of allergens. The national regulations  
15 on food allergen labelling are then critically contrasted with other Asian countries and the EU  
16 Regulation No. 1169/2011, which represents one of the most stringent food regulations in the world.  
17 Improving current allergen labelling limitations and practices would be of great benefit to consumers  
18 to prevent risk of food hypersensitivity.

19  
20 **Keywords:** allergen regulation; food allergy; food safety; precautionary allergen labelling

## 21 22 **Highlights**

- 23
- 24 - Most surveyed food products in Malaysia declared the presence of food allergens according to
  - 25 the national regulations
  - 26 - Ambiguous and contradictory statements could be further improved to avoid confusion
  - 27 - Baby food and confectionaries demonstrated examples of good allergen labelling practices
  - 28 - Reiterates the need for clearer guidance in Malaysia's food allergen labelling regulations
- 29

## 30 **Introduction**

31 Food allergy is an adverse immune reaction that occurs upon exposure to specific food and the  
32 reactions can range from mild (e.g. rash, itchy sensation) to severe (e.g. anaphylaxis) (Moore,  
33 Stewart, & deShazo, 2017). Food allergy affects up to 6% of children and 4% of adults in the global  
34 population (Boye, 2012) and is on the rise throughout Asia (Pang *et al.*, 2017). The prevalence of  
35 food allergy is estimated to be 5 – 10% among infants (Matsuo, Yokooji, & Taogoshi, 2015) and 1.5 –  
36 3% among school-aged children and adults in Japan (Urisu *et al.*, 2014), 4 – 5% of Singaporean  
37 schoolchildren (Lee, Chew, & Goh, 1997) and 6.25% (out of 656) children in Thailand (Santadusit,  
38 Atthapaisalsarudee, & Vichyanond, 2005). Eight foods – cereals containing gluten, egg, milk, soy,

39 peanuts, tree nuts, fish and shellfish contribute to 90% of food allergic reactions (Bush & Hefle,  
40 1996).

41

42 Yadav and Naidu (2015) reported a higher sensitisation towards egg white and cow's milk in children  
43 less than 2 years in Malaysia whilst prawn was the most common food allergen in children up to 12  
44 years (Gendeh, Mujahid, Murad, & Rizal, 2004) and in adults with allergic rhinitis (Wan Majdiah, Nurul  
45 Khaiza, Suzina, Che Maraina, & Norr Suryani, 2016). Malaysia is unique as the population comprises  
46 of three main ethnic groups (Malay, Chinese and Indians) and a few minority groups, each with their  
47 own dietary practices. Although locals share some common dishes i.e. rice, meat products, fish and  
48 vegetables, each ethnic groups has their own typical dishes and ingredients, dietary habits and  
49 restrictions (Fournier *et al.*, 2016). One of the best way to avoid food allergic reactions is to avoid the  
50 trigger food. Education and understanding food labels are crucial to individuals with food allergies  
51 (Lanser, Wright, Orgel, Vickery, & Fleischer, 2015). In order to protect consumers, regulations are in  
52 place in Malaysia where the guidelines for allergen labelling in Malaysia are according to Food  
53 Regulations (1985). Food allergens to be declared include cereal containing gluten (including wheat,  
54 rye, barley and oat), nut and nut products including peanut and soybean, fish and fish product, milk  
55 and milk product (including lactose) and egg and egg product (MOH, n.d.). Precautionary allergen  
56 labelling (PAL) remains voluntary in Malaysia.

57

58 At the global level, Codex stated that the 8 common food allergens shall be declared (Codex, 1985).  
59 As different countries vary in their dietary habits, different countries applied different regulations  
60 across the world e.g. the Food Allergen Labelling and Consumer Protection Act of 2004 (US FDA  
61 2016), Regulation (EU) No. 1169/2011 (EU Regulation No. 1169/2011) and Standard 1.2.3 –  
62 Mandatory Warning and Advisory Statements and Declarations (FSANZ, 2014). Although food allergen  
63 labelling is mandatory and regulated, precautionary allergen labelling (PAL) remains voluntary  
64 (Gendel, 2012) with the exception of Argentina (Argentina Food Code, 2010), Japan (Akiyama, Imai,  
65 & Ebisawa, 2011), Switzerland (Federal Department Affairs, 2005) and South Africa (Department of  
66 Health, Government of South Africa, 2010) where PAL is regulated or prohibited. These had triggered  
67 a number of studies on allergen frequencies and language used such as those conducted in France  
68 (Battisti *et al.*, 2016) and U.S. (Pieretti, Chung, Pacenza, Slotkin, & Sicherer, 2009).

69

70 Studies on consumers' attitudes towards food allergen labelling too been carried out in developed  
71 nations. Marchisotto *et al.* (2017) reported that consumers in U.S. and Canada have poor  
72 understanding of PAL and falsely believing that PAL was required by law. Marra *et al.* (2017) found  
73 that Canadian consumers preferred the use of standardised PAL and safety symbols on food labelling.  
74 Consumers in South Korea recommended that the font size, shape, colour and location of food allergy  
75 information on labels need improvement (Choi & Choi, 2016). Meanwhile, Mfueni *et al.* (2018)  
76 conducted a study in Malawi and found that the country's food allergen labelling was the least

77 demanding compared to other international regulations. Although all surveyed products complied with  
78 the nation's food allergen labelling requirement, none of the locally manufactured products  
79 emphasised food allergens (e.g. bold, italic, different font size) or PAL. Mfueni's study is a positive  
80 step forward for developing countries but data from many Asia countries, including Malaysia are still  
81 lacking. There is also a perception that food allergy prevalence is low in this region (Shek & Lee,  
82 2006). Thus, it is the aim of this study to identify the food allergens declared in food products sold in  
83 Malaysia and to what extent food allergens and PAL are emphasised in the products.

84

## 85 **Methodology**

86 Commercially processed and packaged food products' were evaluated for allergen and precautionary  
87 allergen labelling. Eight recent agricultural or biotechnology graduates were recruited as surveyors for  
88 data collection. Graduates received online training by the researcher and instructions were sent to all  
89 surveyors by email. The study was conducted between May – August 2017. Each surveyor was  
90 assigned to one food category. This helps to reduce collecting data from the same item. The food  
91 categories include snacks (n=78), baked goods (19), confectionary (62), baby food (41), condiments  
92 and sauces (69) and jams and spreads (21), beverages (56), powder and paste (21), instant food  
93 (52), chilled & frozen food (52) and canned food (34). Instant food is defined as convenient food  
94 products that could be eaten readily or prepared using minimal time and ingredients (Karl, Moore, &  
95 Eastman, 1986). Each surveyor surveyed the food items from different parts of Peninsular Malaysia  
96 i.e. North (Penang), West (Perak, Selangor and Melaka), South (Johor) and East (Kelantan). During  
97 the market analysis, surveyor identified the product name, list of ingredients and details of advisory  
98 labels (if any). Two digital photographs were taken for each product. Data were sent to the  
99 researcher for reviewing. Each product was verified to ensure the data entered for the product and  
100 the accompanying photos are correct (Pieretti *et al.*, 2009). Surveyors were contacted to clarify any  
101 blurry photographs. The photographs were evaluated and items such as name of product, list of  
102 ingredients, allergens declaration in the list, contains statement, precautionary allergen label (PAL)  
103 and font type were documented. Data from each label were entered into Excel sheet according to  
104 food category. The ingredient list was checked for declaration of allergens such as gluten, tree nuts,  
105 peanuts, soybean, fish, milk and eggs. This is according to the guidelines for allergen labelling in  
106 Malaysia (Malaysia Food Regulations, 1985 This study also looks at labels that declare crustaceans  
107 and molluscs, as shellfish allergy is prevalent in Malaysia (Gendeh *et al.*, 2004; Wan Majdiah *et al.*,  
108 2016). Multiple food products also provided information about other food allergens that are not  
109 regulated in Malaysia (i.e. celery, lupin, mustard, sesame seed and sulphites) and these were also  
110 documented. In food labels with 'Contains' or PAL statements, the description of the statement and  
111 type of food allergen declared were noted. The font type i.e. bold, italic, contrasting colour,  
112 highlighted, enlarged font or others such as asterisk to demonstrate the presence of food allergens in  
113 list of ingredients, contains statement or PAL were recorded. Labels were further determined for  
114 ambiguous or contradictory statements and examples of good allergen labelling practices. Food

115 products with good allergen labelling practices were identified based on provision of allergen names  
116 in plain English (e.g. casein [milk]), source of generic ingredients such as oil, flour or starch were  
117 provided (Pieretti et al., 2009) and provision of symbols (such as an asterisk) to indicate if an allergen  
118 was present or not (Cornelisse-Vermaat, Voordouw, Yiakoumaki, Theodoridis, & Frewer, 2008).

## 119 **Results and Discussion**

### 120 **Food allergen labelling of food products sold in Malaysia**

121 Labels from 505 food and drink products were assessed. 474 food products declared food allergens in  
122 their ingredient lists or contains statement. These declarations exclude the allergens listed as part of  
123 PAL. Twenty-two variations of PAL were found in 29.3% of the products. All food products' labelling  
124 (99.58%) declared food allergens according to the national food allergen labelling regulations with  
125 the exception of one chicken product and dry bean curd sheets product. The chicken product labelled  
126 ISP in its ingredient list. This may cause confusion and particularly pose a risk to soybean allergic  
127 individuals if the acronym is 'isolated soy protein'. Similarly, the dry bean curd sheets product did not  
128 state (soy) or Contains soy in the label. Figure 1 shows the number and types of food allergens  
129 declared in the products' ingredient list and/or contains statement (none of the allergens listed in PAL  
130 are included). Soybean represents the largest group of food allergen declared, followed by wheat and  
131 milk products (Figure 1). Soybeans were mostly declared in condiments and sauces (17.83%),  
132 confectionary (15.12%) and chilled and frozen products (13.18%). It represents the most common  
133 food allergen due to the use of soy lecithin. Battisti *et al.* (2017) similarly reported that soybeans  
134 were found in 20% of the surveyed products due the addition of soy lecithin. Snacks (19.81%),  
135 instant food (17.87%) and confectionary (13.53%) were the top three food categories containing  
136 wheat while confectionary (20.69%), beverages (20.20%) and baby food (18.72%) were found to  
137 contain the highest amount of milk. Tree nuts such as hazelnuts, almonds, cashews and walnuts were  
138 declared in bread, confectionary, beverages and instant food. Baby food contains the highest number  
139 of fish product especially docosahexaenoic acid (DHA) derived from fish oil. Meanwhile egg protein  
140 was declared across all food categories except baby food and beverages. Condiments & sauces and  
141 chilled & frozen food represent the food categories with the highest number of shellfish products.  
142 Other types of cereal in particular barley and oats were found in instant food products. Sixty-nine  
143 food products declared 'other' food allergens (e.g. mustard, sesame, sulphites, celery). .

144

145 In France, 73% of the food products (out of 17,309) were found to contain at least one allergen in  
146 their ingredients list. The most commonly declared allergen were milk, gluten and egg (Battisti *et al.*,  
147 2017) while in Australia, Zurzolo *et al.* (2013a) found that the most common allergens were wheat,  
148 soy and milk. Food allergen labels are crucial to inform consumers about the presence of the trigger  
149 food. One notable example that demonstrates the importance of food allergen labelling was when the  
150 Beijing Organising Committee for the Olympic and Paralympic Games passed a specific regulation on  
151 food allergen labelling which remained effective until the end of the games. The regulations requires  
152 that a specific list of allergens be clearly labelled on pre-packaged foods and restaurant foods

153 supplied to participants and attendees (Li *et al.*, 2009). Today, the 8 major food allergens are  
154 included in the mandatory regulation in China (Gendel, 2012).

155

156 Insert Figure 1 here

157

### 158 **Contains statement**

159 Two hundred and nine (44.09%) had both 'Contains' statements and allergens listed in the ingredient  
160 list. There were 13 variations of contains statement with 'Contains [allergen(s)]' being the most  
161 common (55.02%), followed by 'Contains ingredients from [allergen(s)]' (14.83%) and 'This product  
162 contains [allergen(s)]' (9.56%) (Table 1). Snacks (20.57%), instant food (14.83%) and condiments &  
163 sauces (13.40%) were the top three food categories with contains statement. In the beverages  
164 category, there was a declaration stating 'No added coffee bean substitutes such as barley, corn or  
165 other cereals'. In addition to targeting allergens such as barley or other gluten containing cereal, this  
166 statement informs customers that the coffee bean used in the product are genuine and not replaced  
167 or mixed with other low-cost or hazardous alternatives. Coffee bean is categorised as a high-price  
168 commodity and is vulnerable to adulteration with cheaper roasted grains. Sources of allergens such  
169 as roasted soybean, wheat middlings, rye, barley and triticale (Toci *et al.*, 2016) can be added to  
170 coffee blends hence posing a threat to individual sensitive to cereal containing gluten or soybean.

171

172 Insert Table 1 here

173

174

175

176 **May contain statement**

177 Out of the 505 food products, 29.3% had a 'may contain' labelling. There were 22 variations of may  
178 contain statements (Table 2). 'May contain traces of [allergen(s)]' was the most common advice  
179 labelling used (55.41%). Other variations such as 'processed in a facility that also processes  
180 [allergen(s)]' occurred in 4.05% of the products whilst labelling containing 'Manufactured on  
181 equipment' or 'Manufactured in a facility' that also processes products containing [allergen(s)] were  
182 found in 4.73% of the items. Snacks (21.62%), confectionary (19.59%) and powder and paste  
183 (18.24%) were the food items with the highest usage of precautionary allergen labelling. Pieretti *et*  
184 *al.* (2009) reported that chocolate candy, cookies and baking mixes were reported with the highest  
185 frequency of advisory allergen labelling in US while a study by Zurzolo *et al.* (2013a) found that 96%  
186 (out of 128) of various processed samples were found to contain label declaring 'may be present' or  
187 'may contain' some of the most common food allergens (e.g. peanuts, tree nuts, egg, milk, soy).  
188 Further analyses revealed that only 7% of the samples had detectable levels of peanuts. However,  
189 these 7% samples still posed a risk to consumers with peanut allergy (Zurzolo *et al.*, 2013a).

190

191 Insert Table 2 here

192

193 Allergens were categorised into 10 categories (gluten, tree nut, peanut, soy, fish, milk, egg,  
194 crustaceans, mollusc and others [e.g. celery, sesame, mustard]). A total of 469 allergens were found  
195 listed under the may contain statement. Milk was the most frequently labelled allergen in the PAL  
196 statement (14.93%), followed by peanuts (14.71%) and tree nuts (14.07%). Precautionary statement  
197 for milk was found mostly in powder and paste product (3.62%), while 'may contain' peanuts and  
198 tree nuts were most frequently declared in snacks (4.26%) and instant food (4.05%). 22.97% of  
199 labels advised at least 2 types of allergens may be present in the product. There was one item  
200 (0.68%) under the powder and paste category that labelled it may contain traces of 8 allergens i.e.  
201 (cereal containing gluten, egg, fish, crustacean, molluscs, milk, peanut and tree nuts). 4.73% of  
202 products from snacks, powder and paste, instant food and chilled products respectively advised that 7  
203 allergens may be present in their products. Similarly, 4.73% of products from snacks, condiments and  
204 sauces, instant food and powder and paste may contain at least 6 types of allergens. In 'others'  
205 allergen category listed under PAL, sesame (48.83%), celery (23.26%), mustard (23.26%), sulphite  
206 (2.32%) and legume (2.32%) may be present. Sesame were mostly labelled in snacks (23.36%),  
207 confectionary (11.63%) and condiments and sauces (6.98%). Sesame seeds are often used as  
208 garnish in confectionary products, snacks such as crackers and chip and oriental cuisines (Chen, Wu,  
209 & Deng, 2015). Sesame allergy is increasingly reported in developed countries including US, Australia,  
210 a number of EU countries, Israel and Japan (Gangur, Kelly, & Navuluri, 2005) and is one of the most  
211 common seed allergy (Li *et al.*, 2017). In this study, celery and mustard were found mostly in powder  
212 and paste category. Both allergens are spices and are widely used in seasonings and flavourings  
213 (Chen *et al.*, 2015). Spice allergy affects between 4 – 13 individuals out of 10,000 adults globally

214 (Chen & Bahna, 2011). Although the allergens labelled under the others category are not specified  
215 under Malaysia Food Regulations 1985, sesame, celery, mustard and sulphites are required by EU  
216 Regulations.

217

218 Companies can further specify the type of legumes that may be present. For example, a canned food  
219 product labelled that it was manufactured in a factory that also processed products containing  
220 legumes. Although peanuts and soybeans are classified as legumes, specifying the type of legume will  
221 be helpful to consumers. Other products such as yeast was labelled as 'Packed in a facility that  
222 processes peanuts, wheat, gluten, soy, milk solids and yeast' under the instant food category.

223 Coconut and seeds were also listed in the advisory labelling of chilled and frozen goods such as pastry  
224 and flatbread. In this case, specifying the seeds (e.g. sesame seeds) would be helpful for consumers.  
225 Although seeds (except sesame seed) are not mandatory in EU or most countries' regulated labelling,  
226 there had been recent report of allergic reactions to pumpkin seeds (Valverde-Monge, Bartolome,  
227 Custa-Herranz, & De las Heras, 2017).

228

229 Thirty-nine percent of products (total n= 17,309) surveyed in France (Battisti *et al.*, 2017), 17%  
230 products (total n = 20,241) in U.S. (Pieretti *et al.*, 2009) and 65% (total n = 1,355) of products in  
231 Australia (Zurzolo *et al.*, 2013b) had precautionary statements. The 3 most popular forms of PAL used  
232 in U.S. are 'may contain [allergen]', 'manufactured on shared equipment with [allergen]' and  
233 'manufactured in the same facility with [allergen]' (Taylor *et al.*, 2007). Forty percent of the surveyed  
234 consumers in U.S. and Canada purchased food with PAL (Marchisotto *et al.*, 2017). This represents a  
235 worrying trend as Hefle *et al.* (2007) and Mills, Wang and Kattan (2016) also found that consumers  
236 with food allergy are increasingly ignoring PAL and take risks with food products. The purpose of may  
237 contain or PAL statements is to inform consumers of unintentional presence of allergens if they were  
238 to consume a given product. However, excessive usage of PAL without appropriate risk assessment  
239 can result in proliferation of multiple PAL statements. As a result, consumers develop 'label fatigue'  
240 over time and may also choose to disregard PAL statements if they did not develop allergic reactions  
241 after consuming products with advisory labelling (Soon & Manning, 2017). Studies had found that  
242 allergic individuals who ignored PAL went on to develop allergic reactions to food products cross  
243 contaminated with food allergens (Sheth *et al.*, 2008; 2010). A number of studies detected food  
244 allergens in food products with PAL statement and those with no food allergens disclosed on the  
245 label. For example, Khuda *et al.* (2016) detected soy protein in 25% of bakery samples with no PAL  
246 and 19% of the samples which had a precautionary statement (n=284). Peanuts were detected in  
247 25% of 'may contain' and 'present in environment' food labelling, while 11% of the samples where  
248 peanut was not disclosed were also tested positive (Pele, Brohee, Anklam & Van Hengel, 2007). In a  
249 separate study, Remington *et al.* (2015) predicted that food products with PAL or no allergen  
250 declaration can contain concentration of allergen that causes a reaction in > 1% of the allergic  
251 population. PAL should be substantiated by a documented formal risk assessment and strategies such



252 as harmonisation of PALs or reducing the variations of PAL (Ben-Shoshan *et al.*, 2012), addressing  
253 the inconsistent usage of PAL and communicate risks to consumers (Soon & Manning, 2017). Zurzolo  
254 *et al.* (2017) suggested innovative ways such as using “may be present” symbol to represent a low  
255 level of cross contamination, toll free number to find out more information about the product or  
256 mobile phone application to scan the barcode of the food product and receive instant information of  
257 the ingredients.

258

259 **Font**

260 The interface design used to differentiate allergens in the ingredient list, contain and may contain  
261 statements vary among the 474 food items. Less than half of the products (43.46%) used 254  
262 different interfaces in combination or individually. Bold font (33.86%), brackets (51.57%), capital  
263 letters (8.66%) and other forms (5.91%) were used to inform consumers about the presence of  
264 allergens. One product used italic font, 2.36% were found with different font sizes and 1.18% with  
265 different colour or a lighter background. 1.97% products used an asterisk e.g. vitamins\* to inform  
266 consumers that the vitamins \*contain soybean oil. Similarly, an asterisk was presented in preservative  
267 (sulphur dioxide)\* to declare that the product \*contains preservative as sulphite in some fruits. These  
268 are examples of good allergen labelling practices where the manufacturers or packers provided clear  
269 and thorough information of the product's contents. The typefaces comply with Regulation No. 12  
270 (Sub-regulation 4) of Malaysia Food Regulations (1985), where the statement of ingredients are not  
271 smaller than 4 point lettering and legible. Mfueni *et al.* (2018) also reported that imported food  
272 products in Malawi also used different emphasis (e.g. bold, italics, enlarged font or contrasting colour)  
273 on the list of ingredients

274

275 FALCPA (2004) provided manufacturers with two options to label food allergens i.e. to include the  
276 name of the food source in parenthesis (e.g. Ingredients: whey (milk), eggs) if the name of the food  
277 source of the major allergen does not appear elsewhere in the list of ingredients or manufacturers  
278 can use 'Contains [allergens] immediately after or adjacent to the list of ingredient. EU Regulation No  
279 1169/2011 mandate that food allergens on the regulatory list is to be emphasised e.g. using bold,  
280 italics, highlighted or underlined font to identify them if used as ingredients in a pre-packaged food.  
281 Recent changes to the EU Food Information for Consumers Regulation (EU FIC) Regulation No.  
282 1169/2011 stated that allergy boxes such as 'Contains [allergens]' is no longer allowed. The  
283 regulation however permits the usage of icons or symbols to indicate the presence of allergens as  
284 long as it is with accompanied words or numbers to ensure uniform consumer understanding (FSA,  
285 2015). Previous research in EU reported customers facing difficulty when reading information on label  
286 particularly in terms of font sizes being too small, colour contrast of label, visibility problems when  
287 reading glossy materials (Cornelisse-Vermaat *et al.*, 2008). Dutch customers also liked the usage of  
288 symbols on the package to indicate if an allergen was present or not. However, they prefer textual  
289 allergen information to be included in addition to symbols (Cornelisse-Vermaat *et al.*, 2008). This was  
290 prior to the change in the EU FIC regulation.

291

292 Consumers in South Korea were concerned about the font size of the food allergen information and  
293 considered them too small to be noticeable (Choi & Choi, 2016). Regulations in South Korea specified  
294 that the font size should be bigger than 12 points. The location of the allergic information, which  
295 appears below the nutrition information, was also barely noticeable (Choi & Choi, 2016). Cornelisse-

296 Vermaat *et al.* (2008) reported that participants perceived the readability of the label (font size and  
297 contrast) could be improved.

298

### 299 **Ambiguous declaration**

300 There were 199 ambiguous labelling found in the food products where sources of ingredients were  
301 unknown. Categorically, this can be divided into source of oil or shortening (26.13%), type of flour or  
302 starch (18.09%) and others (e.g. emulsifier, thickener, source of lecithin, conditioner, hydrolysed or  
303 textured vegetable protein, spices, breadcrumbs and flavourings) (55.78%). Maltodextrin were  
304 excluded in this study. Although Food Regulations 1985 did not mention maltodextrin, EC 1169/2011  
305 stated that wheat-based maltodextrin, wheat-based glucose syrup and wheat-based dextrose are  
306 exempted from food allergen labelling.

307

308 Chilled and frozen food recorded the highest number of ambiguous labels (28.64%). 25% of the  
309 labels did not specify the type of oil or shortening used, 50% of the labels did not state the source of  
310 flour used (e.g. high protein flour, starch) and 23.42% could further provide information about the  
311 source of lecithin, spices, flavours, binders and emulsifier. A chicken nugget product labelled ISP in its  
312 ingredient list. Assuming that ISP is isolated soy protein, not stating the full product name may put  
313 soybean allergic individuals at risk. This was reported by Mittag *et al.* (2004) who found that patients  
314 were allergic to dietary product containing soy protein isolate. Beverages recorded 15.07%  
315 ambiguous labels and could further improved the labelling by providing the source of oil (15.38%)  
316 and other ingredients (19.82%). Most products only provided generic terms such as hydrogenated  
317 vegetable oil or fat, malt, malt extract powder, emulsifier, thickener and conditioner. In beverages,  
318 cereals used to make alcoholic distillates are exempted from food allergen labelling. Although  
319 maltodextrin was excluded in this study, some baby formula products demonstrated good allergen  
320 labelling practices and also listed the sources of maltodextrin (e.g. from corn or potato starch).

321

322 About 14% of snacks' labels were confusing. Generic terms were found in 19.23% of oil (e.g. cooking  
323 oil, vegetable oil, vegetable fat and popping oil), 22.22% of flour and 9.01% of other ingredients  
324 (hydrolysed vegetable protein, emulsifier). The term popping oil was found in a popcorn product.  
325 Food manufacturers used the generic term 'vegetable oil' as the type of oil used in production may  
326 change due to supply issues. However, there are several widely used oil that are derived from plants  
327 commonly known as food allergen e.g. peanut, soy (Crevel, Kerkhoff, & Koning, 2000) and sesame.  
328 In fully refined oil, protein are almost completely removed and do not present risk of allergic reactions  
329 in the majority of susceptible individuals (Blom *et al.*, 2017; Crevel *et al.*, 2000). The amount of  
330 protein in refined peanut oil is estimated at 0.1 – 0.3 µg/ml (Olszewski *et al.*, 21998; Ramazzotti *et*  
331 *al.*, 2008) and refined soy oil is 0.32 µg/ml (Errahali *et al.*, 2002). Sesame oil is commonly used  
332 directly without refining for culinary purposes (Olasunkanmi, Omolayo, & Olusegun, 2017) and had

333 been reported to cause hypersensitivity in susceptible individuals (Gangur *et al.*, 2005). Crude oils are  
334 estimated to be between 3 – 13 µg/g (Crevel *et al.*, 2000).

335

336 A total 34 discrepancies (difference between ingredient list and contains statement) were found in all  
337 food categories except baby food and powder and paste products. In nine food products, food  
338 allergens were listed in the ingredients but not included in the contain statement. For example, a  
339 wafer product has wheat, soybean and milk listed as ingredients but only declared 'Contains wheat  
340 and milk'. Meanwhile the other 25 products declared allergens in the contain statement although  
341 these were not listed in the ingredients. In a codfish snack, soybean was declared in the allergen  
342 advice as: 'Contains wheat, soy product and seafood'. Although fish meat and wheat flour were  
343 declared in both ingredient list and contain statement, soybean was not. Both snacks and chilled &  
344 frozen food recorded 23.53% of the discrepancies.

345 A cracker product labelled wheat and milk in the ingredient list, but also declared the following "This  
346 product contains wheat and is manufactured in a facility that may process products that contain  
347 celery, peanuts, tree nuts, sesame, dairy and soy'. Only wheat was declared in the contain  
348 statement, while the precautionary statement stated that it may contain milk. The declaration of milk  
349 in both the ingredient list and the advisory list may create confusion among consumers. Similarly, a  
350 coated peanut product declared wheat and peanuts in the ingredient list but also stated 'this product  
351 contains other tree nuts' in the contain statement. Furthermore, the product's PAL was repeated  
352 twice 'Produced in a facility that also produces gluten (wheat) and peanuts. May contain gluten  
353 (wheat) and peanuts'. Although wheat and peanuts were declared in the ingredients list, the advisory  
354 labelling informed consumers that the product may contain wheat and peanuts. Fourteen food  
355 products repeated the advisory labelling. For example, in the snack category, the repetition was as  
356 follow: 'This product is produced in a facility that also produces peanuts, tree nuts and gluten. May  
357 contain peanuts, tree nuts and gluten'. Confectionary products such as nut coated chocolate were  
358 labelled as 'May contain traces of other nuts. Allergen info: Made by equipment that also processes  
359 products that contain peanuts, tree nuts, sesame and cereals that contain gluten'.

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367 Ambiguous and contradictory labelling may cause confusion among consumers. The discrepancy  
368 between the allergens declared in the ingredients list and contains statement or allergy information  
369 may be a possible disadvantage as consumers may rely only the contain statement and ignore other  
370 potential allergens listed in the ingredients (Ben-Shoshan *et al.*, 2012). Statements that are vague are  
371 inappropriate for consumers to assess risk accurately (Pape, 2009). Food labels serve as the interface  
372 between consumers and the pre-consumption food system (i.e. farm to point of sale). Tonkin, Well,  
373 Coveney, Meyer & Wilson (2016) named this a vulnerability point as correct labelling and awareness  
374 from consumers will mitigate potential risks such as consumption of undeclared or unintentional  
375 presence of food allergens.

376

### 377 **Good allergen labelling practices**

378 The following food categories demonstrated good allergen practices (Table 3). This is in addition to  
379 meeting the requirements of Malaysia's Food Regulations 1985. Baby and young children food  
380 category which consists of infant formula and cereal-based foods for infants and young children has  
381 the highest number of good allergen labelling practices. Ingredients list contain simple food allergen  
382 name adjacent to jargons such as lactose (milk), whey (milk), emulsifier (soy lecithin) and  
383 docosahexaenoic acid (fish oil). Young babies are at higher risk to foodborne diseases (Worsfold,  
384 1996) hence baby food manufacturers have to be extra vigilant in ensuring quality of the raw  
385 materials, processing and safety of baby food (Featherstone, 2016). Baby food in Malaysia is guided  
386 by Food Regulations (1985) in Part VIII Standards and particular labelling requirements for food. In  
387 addition to adopting good hygienic practices whilst handling milk, parents and carers should pay  
388 attention to reading and understanding baby and young children's food labels. Confectionaries came  
389 in second with 52 good allergen labelling practices. Noteworthy examples include listing the source of  
390 oil (which also contains source of emulsifier) and colouring (tartrazine). Tartrazine (E102) is one of  
391 the six food colours linked to hyperactivity in children (Bateman *et al.*, 2004; McCann *et al.*, 2007). In  
392 EU, food and drinks that contain tartrazine, sunset yellow, quinolone yellow, carmoisine, allura red  
393 and ponceau 4R must carry the warning 'may have an adverse effect on activity and attention in  
394 children' (EC Regulation No 1333/2008, 2008; Oplatońska-Stachowiak, & Elliott, 2017). Shek and Lee  
395 (2006) reported that labelling of foods manufactured or packaged in Asia needs to be improved. By  
396 improving some of the current limitations in the surveyed products and using the examples of good  
397 allergen labelling practices, Malaysia's food manufacturers, packers and importers will be able to  
398 benchmark against other stricter and comprehensive food allergen labelling regulations.

399

400 Insert Table 3 here

401

### 402 **Food allergen labelling regulations**

403 Table 4 compares Malaysia's food allergen labelling regulations against Codex, other Asian countries  
404 and the EU. The Codex Alimentarius Commission Committee on Food Labelling has listed the major

405 food allergens and ingredients known to cause hypersensitivity (Codex, 1985). Countries use Codex's  
406 list as a national benchmark to define and establish their own country's allergen list based on dietary  
407 habits and geographical regions. Malaysia Food Regulations (1985) requires the declaration of cereal  
408 containing gluten, eggs, fish, milk, peanuts, soybeans and tree nuts. Indonesia shares a similar list to  
409 Codex with the exception of sulphites (> 100 ppm). Japan, South Korea and member countries of the  
410 EU are interesting examples demonstrating specific allergens vary by countries and reflect differences  
411 in dietary preferences and culture. For example, buckwheat is an important allergen in Japan and  
412 Korea (Akiyama *et al.*, 2011; Han, Kim, & Ahn, 2012) as is the case of celery, mustard, sesame, lupin  
413 and mollusc which have been identified as significant allergens in European countries (Tsabouri,  
414 Feketea, & Nikolaou, 2017).

415

416 In Thailand, allergen information for pre-packaged foods were required since 2014 based on  
417 Notification No. 367 (Royal Thai Government Gazette, 2014). This was based on Surojanametakul *et*  
418 *al.* (2012) study that reported one third of Thai commercial food products contained undeclared  
419 allergens greater than 10 ppm. Thailand's food labelling had evolved over the years and now  
420 contributes to international food labelling policies (Rimpeekool *et al.*, 2015). The Agri-Food and  
421 Veterinary Authority of Singapore does not encourage the use of precautionary allergen labelling such  
422 as "May contain" to declare the presence of allergens or substances known to cause hypersensitivity.  
423 Food traders who use PAL may be required to provide justification to customers if concerns were  
424 raised regarding potential food allergens in the products (AVA, 2017).

425

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428 Insert Table 4 here

429

430 Crustaceans are listed as major allergens in most countries listed in Table 4. It is not specify in  
431 Malaysia's listing of foods causing hypersensitivity. However, studies found that prawn was the most  
432 common food allergen in children up to 12 years (Gendeh *et al.*, 2004) and in adults with allergic  
433 rhinitis in Malaysia (Wan Majdiah *et al.*, 2016). Similarly, other neighbouring countries reported  
434 shellfish allergy in Thailand (Lao-araya & Trakultivakorn, 2012), Philippines (Shek *et al.*, 2010),  
435 Singapore (Chiang *et al.*, 2007) and China (Chen, Hu, Allen, Ho, & Li, 2011; Chen *et al.*, 2012). This  
436 reiterates the need for clearer guidance in Malaysia's food allergen labelling regulations.

437

#### 438 **Conclusion**

439 Successful avoidance of food allergens rely on accurate and clear food labelling. Although more than  
440 99% of the surveyed food products' labelling declared the presence of food allergens according to the  
441 local regulations, there still exists multiple cases of missing, ambiguous and contradictory statements  
442 in the labels. On a more positive side, some food categories demonstrated good allergen labelling

443 practices that could be emulated by other food manufacturers and packers. At this time, there  
444 remains extensive work in determining food allergy prevalence and levels of undeclared allergens in  
445 Malaysia. Studies on consumers' attitudes and purchasing habits of food products with allergens and  
446 PAL can be used to identify the needs of consumers. Improving current allergen labelling regulations  
447 and practices would be of great benefit to consumers to prevent risk of food hypersensitivity.  
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