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Labelling of allergens and intolerance-causing foods in Ukraine

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Abstract. The number of consumers with food allergies or intolerances is rapidly increasing worldwide. Legislation in many countries, including Ukraine, defined a list of substances and foods that cause allergic reactions or intolerances. It also establishes requirements for allergen labelling on food packaging, which manufacturers must comply with. The purpose of this study was to determine, how food manufacturers in Ukraine indicate the presence of substances and ingredients that may cause allergic reactions and intolerances, and whether such labelling meets the requirements of Ukrainian legislation. For the label analysis, food products were grouped into 10 categories: sausages, bakery products, cookies and waffles, dairy products, sauces and mayonnaises, cheeses, snacks, instant foods, confectionery and ice creams. The study was conducted by analysing food labels from local supermarkets in Lutsk, Ukraine. It was found that the majority of the foods analysed contained allergens or ingredients that cause intolerance. Between 8% and 22% of food products in different categories did not have allergens properly identified on the labels, even though they were present. On food labels, Ukrainian manufacturers mainly used bold type to highlight substances and ingredients that may cause allergies and intolerances (74.0-100.0% of products). Only 4.0-28.3% of product labels used capital letters to highlight these substances and ingredients. Text highlighting through colour, style, background and underlining was much less common and was most often combined with bold text. The terms "contains" and "may contain traces of" appeared on the labels of 6.0-36.0% and 6.0-76.1% of foods, respectively. The most common ingredients on the labels of the food products analysed were processed cereal products containing gluten, eggs, milk or dairy products, processed soy products, peanuts, and nuts. The results of the analysis showed that Ukrainian producers generally comply with Ukrainian legislation regarding the labelling of substances or ingredients in food products that may cause allergic reactions or intolerance

Keywords: allergy; consumer protection; label requirements; ingredient disclosure; regulatory standards

Introduction

Food allergy is a major public health problem with an increasing prevalence in urbanised areas, significantly impacting the lives of affected individuals with allergies and their families (Peters *et al.*, 2021). A. Muraro *et al.* (2022) found that food allergy affects approximately 2-4% of children and adults. In line with the global trends, food allergy is increasingly reported in Europe (Spolidoro *et al.*, 2022). The scientists A.B. Conrado *et*

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al. (2021) noted that commonly consumed foods, including milk, bread, eggs, fish, nuts, and soya, can cause food allergies, leading to potential health risks for those with intolerances. Globally, cow's milk and shellfish/crustaceans are among the most common causes of anaphylaxis, a life-threatening allergic reaction, alongside peanuts and tree nuts. The authors D. Gargano *et al*. (2021) stated that in some severely allergic individuals, even a very small amount of food can cause a life-threatening reaction.

Researchers C.L. Jansson-Knodell *et al*. (2020) emphasised that non-allergic food reactions, such as food intolerance, were often confused with food allergies. With prevalence rates ranging from 4% to 20% of the general population, food intolerances can present with a variety of symptoms, including gastrointestinal complaints such as flatulence, abdominal pain, bloating, and diarrhoea.

To protect food-allergic consumers from accidental exposure to allergenic foods, allergen labelling regulations and guidelines, including the Codex Alimentarius. International food standards (2025), have been developed and adopted, based primarily on the scientific research. EU countries and Ukraine require pre-packaged foods to be labelled with the 14 major allergens. In some countries, there are no regulations for pre-packaged foods that may be at risk of cross-contamination with food allergens during the manufacturing process, and food manufacturers often use precautionary allergen labelling (PAL) (i.e., "may contain" statements) to address this gap. As pointed out by J.C. Li *et al*. (2024), PALs, such as "may contain" or "may contain traces of", often cause confusion among consumers, as foods with these labels typically contain only low or trace levels of allergens. Consumers with allergies may find it difficult to assess, how safe such products were for them and whether consuming them may cause adverse health effects. Therefore, ongoing efforts were focused on defining thresholds for the presence of allergens in processed foods that would indicated the need for PALs (Stankovich *et al.*, 2023).

The authors W.M. Blom *et al*. (2021) noted that for consumers with food allergies, the allergen information section of food labels was an important and often crucial communication tool for avoiding the allergen(s). For allergens used as ingredients in specific foods, allergen labelling must be clear and understandable to consumers and comply with local regulations. M.L. Cunha *et al*. (2020) highlighted that identifying the possible allergens present in each food was a challenge for consumers, especially with derivatives (e.g. the term "vegetable oil" often does not specify the origin of the product, which could be soy, peanut, sunflower). In many countries, including Ukraine, regulations required that food products containing allergens or products causing intolerance (PCIs) must be highlighted from other information on the label by font, background colour, style.

The purpose of this research was to examine, how Ukrainian manufacturers label allergens and intolerance-causing products on pre-packaged food labels and whether they comply with Ukrainian legislation regarding the provision of allergen information to consumers.

Materials and Methods

Food sampling was carried out in Lutsk (Ukraine) from October to November 2024. Food samples were collected from the supermarkets "Salyut", "ATB", "Tam Tam", "Silpo", "Forta" and five local mini-markets. Food products were categorised into ten groups as shown in Table 1. From each product group, 50 samples of packaged foods from different manufacturers were randomly selected. Only food products produced in Ukraine were selected.

Table 1. *Food groups*

Food group	Foods included in the group	Number of samples
Sausages	Various types of cooked and fermented sausages	50
Bakery products	Various types of bread, loaves, buns, pita bread	50
Cookies and waffles	Various types of biscuits, waffles, crackers	50
Dairy products	Milk, butter, yogurt, kefir, fermented baked milk, sour cream, cream, ayran, milkshakes	50
Sauces and mayonnaises	Various types of mayonnaise, sauces, dressings, tomato pastes	50
Cheeses	Various types of hard, semi-hard and soft cheeses	50
Snacks	Toast, crackers, popcorn, potato chips, fruit chips, bars, peanuts, sunflower and pumpkin seeds	50
Instant food	Various types of instant noodles, pasta, soups, cereals and vegetable purées	50
Confectionery	Cakes, pastries, zefirs, marmalade	50
Ice creams	Various types of milk-based ice cream	50

Source: *developed by the authors*

For food products with multiple package sizes, only one size was included in the analysis to avoid bias (Battisti *et al.*, 2017). Duplicate food products found across the supermarkets and grocery stores were recorded only once (Ontiveros *et al.*, 2020). Information was captured via photo camera and consisted of the following (Soon, 2018): food product brand, place of manufacture, ingredients, declaration of food products

and substances that cause food allergies and intolerance (precautionary labelling statements), and special typography of allergen labelling (bold, font style, highlighted, coloured). Figure 1 showed an example of a photographed label of a confectionery product with allergen and PCI information.

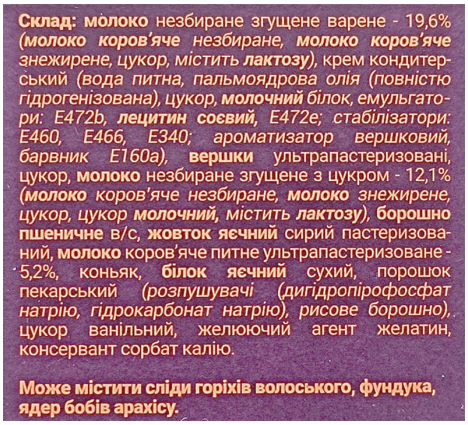

Figure 1. *Confectionery label in Ukrainian with allergens and PCIs highlighted in bold*

Note: ingredients: *condensed boiled* ***whole milk*** *– 19.6% (****whole cow's milk****, skimmed* ***cow's milk****, sugar, contains* ***lactose****), confectionery cream (water, palm kernel oil (fully hydrogenated), sugar,* ***milk*** *protein, emulsifiers: E472b,* ***soya lecithin****, E472e; stabilisers: E460, E466, E340; cream flavour, colour E160a), ultra-pasteurised* ***cream****, sugar, sweetened condensed* ***whole milk*** *– 12.1% (****whole cow's milk****, skimmed* ***cow's milk****, sugar,* ***milk sugar****, contains* ***lactose****),* ***wheat flour****, pasteurised raw* ***egg yolk****, ultra-pasteurised* ***cow's milk*** *– 5.2%, cognac, dried* ***egg white****, baking powder (raising agents (sodium dihydrogen pyrophosphate, sodium bicarbonate), rice flour), vanilla sugar, gelling agent: gelatine, preservative: potassium sorbate;* ***may contain traces of walnuts, hazelnuts, and peanuts***
Source: *developed by the authors*

Pre-packaged food products were verified for compliance with the Ukrainian regulation on food allergen labelling (Law of Ukraine No. 2639-VIII, 2018). Ukrainian legislation identified 14 substances and foods that may cause allergic reactions and intolerance in consumers (Table 2). These substances and foods must be declared to consumers on food labels. Pre-packaged foods were checked for correct labelling of food allergens and PCIs as defined by Ukrainian legislation. Taking into account the requirements of the Ukrainian legislation, the following characteristics of food labels were examined: identification of the food allergens or PCIs (using capital letters, bold letters, background colour, font style, different colours than the label, text underlining, etc.) among the other ingredients in the list of ingredients; labelling statements for allergens or PCIs with the legends "contains" or "may contain" or "may contain traces of"; number of allergens in the food product.

Table 2. *Substances and foods that cause allergic reactions or intolerance*

Substance and food number	A substance or food that causes allergic reactions or intolerance	Exclusion
F1	Cereals containing gluten (wheat, spelt, kamut, rye, barley, oats), their hybrids and grain processing products	Wheat-based glucose syrups, including dextrose; wheat-based maltodextrins; barley-based glucose syrups
F2	Crustaceans and crustacean processing products	–
F3	Eggs and processed egg products	–
F4	Fish and fish products	Fish gelatin used as a carrier for vitamins, as a clarifying agent for beer and wine
F5	Peanuts and processed peanut products	–
F6	Soybeans and soy-based products	Fully refined soybean oil and fat
F7	Milk and dairy products	Whey used in the production of alcoholic distillates
F8	Nuts (almonds, hazelnuts, walnuts, cashews, pecans, Brazil nuts, pistachios, macadamias, Queensland nuts)	Nuts for the production of alcoholic distillates
F9	Celery and celery products	–
F10	Mustard and mustard products	–
F11	Sesame seeds and sesame products	–
F12	Sulpfur dioxide and sulphites in concentrations exceeding 10 mg/kg or 10 mg/L	–
F13	Lupine seeds and processed lupine products	–
F14	Molluscs and mollusc products	–

Source: *compiled by the authors based on the Law of Ukraine No. 2639-VIII (2018)*

All food ingredient lists were checked for the presence of undeclared allergens or PCIs. Foods without allergen or PCI labelling, but containing them as ingredients were included. Only foods with allergens and PCIs were included in the analyses of compliance with the Ukrainian regulation on food allergen labelling. Methods of descriptive statistics were used, and the results were presented as percentages. The sample size of foods in each food group was calculated with a confidence probability of P = 0.95, resulting in a sample size of 50 products for each group (Marmoza, 2009).

Allergen-free foods were only included, when calculating the percentage of products with no allergens or with varying amounts of allergens and PCIs. For all other indicators, allergen-free foods were not included in the calculation (the results of such calculations were marked with). Results were displayed using Excel 2016 software.

Results and Discussion

The labels of 50 food products manufactured in Ukraine were analysed to determine whether manufacturers complied with Ukrainian legislation on allergen labelling for packaged foods. In particular, it was important to identify the most common ways of labelling allergens or PCIs. For sausages, 24% of the products contained 2 allergens or PCIs, while 18% contained 6 allergens or PCIs (Fig. 2). 12% of the sausages contained either 3 or 5 allergens or PCIs, and 2% contained 1 or 8 such allergens or PCIs. 4 and 7 food allergens or PCIs were found in 16% and 14% of the sausages, respectively.

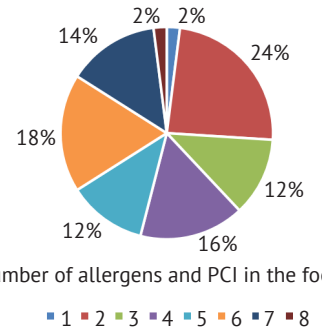

Figure 2. *Percentage of foods (sausages) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

On the labels of 62% of the sausages, allergens and PCIs were listed following the phrases "contains" and "may contain traces of" (Table 3). In 44% of the sausages, allergens and PCIs appeared in the ingredient list. Manufacturers did not use the word "contains" to indicate allergens and PCIs on sausage labels. They also did not include the names of products or substances that may cause allergies or intolerances in the brand names of the sausages. In the names of sausage products, the word "sausage" was usually followed by the type of meat used to make it or the name of the town or region, where the product was traditionally made. For example, sausages may be named after the specific meat, such as "Pork sausage" or "Beef sausage", or after the geographical location, such as "Krakowska sausage" or "Lvivska sausage", reflecting the local culinary heritage.

Table 3. *Percentage of foods with different ways of indicating allergens or PCIs on the package label*

Food group	Percentage of foods in each group with different ways of indicating allergens or PCIs on the package label (%)			
	I	C	MC	P
Sausages	44.0	–	62.0	–
Bakery products	100.0	36.0	24.0	2.0
Cookies and waffles	100.0	18.0	76.0	42.0
Dairy products	100.0	–	6.0	–
Sauces and mayonnaises	83.8*	–	54.1*	–
Cheeses	100.0	6.0	12.0	–
Snacks	100.0*	–	61.4*	–
Instant food	87.0*	6.5*	76.1*	–
Confectionery	100.0*	15.2*	67.4*	–
Ice creams	100.0	–	60.0	–

Note: *I – Ingredients; C – Contains; MC – May contain or May contain traces of; P – the name of the product makes a clear reference to the allergen or PCI (milk, peanut butter, etc.); * – value excluding allergen-free products*
Source: *developed by the authors*

Allergens and PCIs were printed in bold on 100% of the sausage labels (Table 4). A combination of bold and capital letters was used to highlight allergens and PCIs on 6% of sausage labels. This helped quickly draw the buyer's attention to important information. Additionally, text underlining was used in combination with other methods to highlight allergens and PCIs on 2% of the labels. No sausages were found without allergen labelling. When indicating allergens and PCIs on sausage labels, manufacturers did not use text highlighting with colours, fonts or contrasting text backgrounds. Typically, the label featured black text on a white background. This was a classic option that offers high contrast and good readability.

Table 4. *Percentage of products with different ways of identifying food allergens or PCIs among the other ingredients in the list of ingredients*

Food group	Percentage of products with different typography of allergen labelling (%)						
	NLA	CL	BF	CLC	DBC	DLS	TA
Sausages	–	6.0	100.0	–	–	–	2.0
Bakery products	10.0	8.0	86.0	–	–	36.0	–
Cookies and waffles	–	12.0	100.0	–	–	16.0	12.0
Dairy products	–	–	94.0	–	2.0	20.0	–
Sauces and mayonnaises	–	–	100.0*	–	–	–	–
Cheeses	22.0	16.0	74.0	–	–	–	12.0
Snacks	–	–	84.1*	–	–	22.7*	9.1*
Instant food	–	28.3*	87.0*	–	–	2.2*	–
Confectionery	–	10.9*	89.1*	39.1*	–	–	–
Ice creams	8.0	4.0	92.0	8.0	–	8.0	4.0

Note: *NLA – non-labelled allergens and PCI; CL – capital letters; BL – bold font; CLC – contrasting letter colours; DBC – different background colours; DLS – different letter styles; TA – text underlining; * – value excluding allergen-free products*

Source: *developed by the authors*

The labels of 90% of the sausages (Table 5) indicated that the products contained milk or its derivatives (e.g. milk powder, cream powder, whey). 70% of sausage labels stated that the products may contain traces of gluten and mustard. 68% of the labels noted that the products contain or may contain traces of egg products (e.g. egg melange). Soy-based products (mainly hydrolysed soy protein) were mentioned on the labels of 64% of sausages. The possible presence of traces of nuts and celery was mentioned on 22% and 48% of labels, respectively. About 2% of labels stated that the products contain or may contain (may contain traces of) peanuts, sesame seeds and sulphites. Traditional sausage products for Ukrainian consumers usually do not contain fish or seafood in their recipes. As a result, these ingredients were generally not listed on the labels of sausage products from Ukrainian producers. This reflected the traditional preferences and culinary practices in Ukraine, where sausages were primarily made from meats such as pork, beef, or poultry, rather than seafood.

Table 5. *Percentage of foods containing different substances and ingredients that cause allergic reactions or intolerance*

Percentage of foods containing different substances and ingredients (%)	F14	–	–	–	–	–	–	–	–	–	–
	F13	–	6.0	4.0	–	–	–	–	–	–	–
	F12	2.0	–	26.0	–	–	–	6.8*	–	4.3*	-
	F11	2.0	24.0	48.0	–	10.8*	–	6.8*	28.3*	–	40.0
	F10	70.0	20.0	2.0	–	78.4*	–	13.6*	10.9*	–	–
	F9	48.0	8.0	2.0	–	2.7*	2.0	4.5*	26.1*	–	–
	F8	22.0	10.0	32.0	6.0	2.7*	12.0	31.8*	34.8*	6.5*	76.0
	F7	90.0	40.0	80.0	100.0	54.1*	100.0	56.8*	63.0*	71.7*	100.0
	F6	64.0	36.0	82.0	8.0	24.3*	–	63.6*	39.1*	15.2*	84.0
	F5	2.0	10.0	70.0	4.0	5.4*	–	54.5*	23.9*	6.5*	64.0
	F4	–	–	–	–	–	–	4.5*	–	–	–
	F3	68.0	26.0	52.0	4.0	59.5*	–	20.5*	17.4*	91.3*	52.0
	F2	–	–	–	–	–	–	4.5*	–	–	–
	F1	70.0	100.0	100.0	4.0	18.9*	–	70.5*	93.5*	76.1*	72.0
Food group		Sausages	Bakery products	Cookies and waffles	Dairy products	Sauces and mayonnaises	Cheeses	Snacks	Instant food	Confectionery	Ice cream

Note: *F1…F14 – substances and foods that cause allergic reactions or intolerance, as indicated in Table 2; * – value excluding allergen-free products*

Source: *developed by the authors*

About 42% of the analysed bakery products contained an allergen or PCI (Fig. 3). These products were mainly traditional wheat or rye bread. 2 allergens or PCIs were found in 12% of the bakery products, while 3

allergens or PCIs were present in 24%. Additionally, 8% of the products contained 4 allergens or PCIs, and 5% contained 5 allergens or PCIs. 4% of bakery products contained 6, 9, or 10 allergens or PCIs in their composition. A high number of allergens was characteristic of bakery products containing whole seeds and nuts. On the labels of 100% of the bakery products, allergens and PCIs were listed in the ingredient composition (Table 3), while on the labels of 10% of the products, allergens and PCIs were not highlighted in any way (Table 4). Before mentioning the allergen or PCI, 36% of the bakery product labels included the legend "contains", while 24% contained the phrase "may contain" (Table 3). In these cases, the most common labels were "contains gluten" or "may contain traces of mustard oil, dairy products". In 2% of the products, the name itself referred directly to the allergen or PCI (e.g., the product name "Sesame Burger Bun"). In the vast majority of bakery product labels (86%), allergens and PCIs were highlighted in bold in the product composition (Table 4). For 36% of bakery products, allergens and PCIs were indicated using bold, capital letters combined with a different font style. Only capital letters were used to indicate allergens and PCIs on the labels of 8% of the products. No bakery products had allergens or PCIs labeled in colour or with a different background.

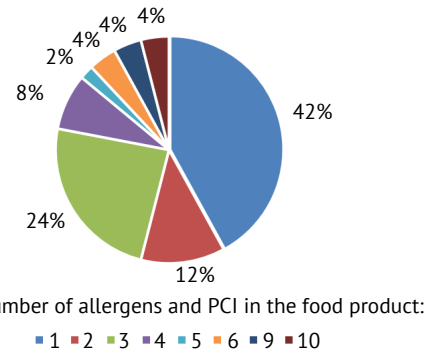

Figure 3. *Percentage of foods (bakery products) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

All bakery products (100%) contained processed cereal products (Table 5), specifically wheat and rye flour, which include gluten. 40% of the products contained milk or dairy products, while 26% contained eggs or egg products. 36% of bakery products were labelled with soy-based products (mainly soy lecithin). About 20% of bakery products contained traces of mustard oil, and 24% contained sesame seeds. 10% of bakery products contained peanuts and tree nuts. Additionally, bakery products may contain traces of celery and lupine, which were labelled in 8% and 6% of products, respectively. When examining the cookie and waffle labels, it was found that 46% of the products contained 6 allergens or PCIs, while 22% contained 4 allergens or PCIs (Fig. 4).

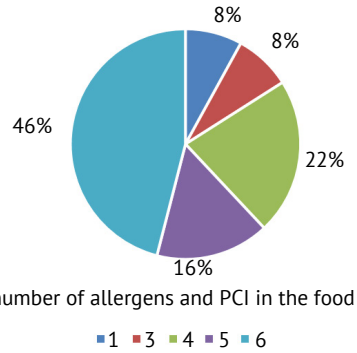

Figure 4. *Percentage of foods (cookies and waffles) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

Additionally, 16% of the cookies and waffles contained 5 allergens or PCIs, and 8% contained 1 or 3 allergens. All cookie and waffle labels (100%) listed allergens and PCIs in the product composition (Table 3). However, in most cases (76%), the allergen or PCI was preceded by the phrases "may contain" or "may contain traces of". About 18% of cookie and waffle labels featured the legend "contains" before the allergen or PCI. In 42% of products, the name of the ingredient clearly indicated a specific substance or food product that was an allergen or caused intolerance (e.g., cow's milk). All labels (100%) of cookies and waffles presented allergens and PCIs in bold (Table 4). On the labels of 12% of the products, bold text was combined with capital letters, while on 16% of the packaged cookies and waffles, bold text was combined with a text style change for ingredients that are allergens or PCIs. For some products (12%), allergens and PCIs were not only highlighted in bold and with a text style change, but also underlined.

All cookies and waffles (100%) contained processed cereal products (Table 5), including wheat and oat flour, both of which contain gluten. 82% of the cookie and waffle labels reported the presence of processed soybean products (soy lecithin). Additionally, 80% of this product group contained cow's milk or its processed products (whey, etc.). A significant percentage of products (70%) contained peanuts or their derivatives. About 52% of the cookies and waffles contained eggs or processed egg products. The presence of sesame seeds, sesame products, or traces of sesame was mentioned on 48% of the labels. In addition, 32% of the products in this group contained nuts (unspecified type) or traces of nuts. Sulphur dioxide and sulphites, used as preservatives, were found in 26% of the products, as indicated on the labels. Some individual products in this group were labelled as containing traces of lupine (4%), celery (2%), and mustard (2%). About 90% of dairy products listed a single ingredient (cow's milk) on the label, the protein of which can cause allergy and the milk sugar (lactose) of which can cause intolerance (Fig. 5).

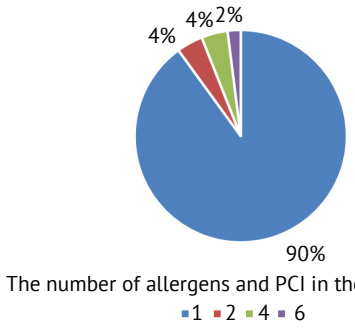

Figure 5. *Percentage of foods (dairy products) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

4% of dairy products contained 2 allergens or PCIs, and a further 4% contained 4 allergens or PCIs. Additionally, 2% of products in this group contained 6 allergens or PCIs. Allergens and PCIs were listed in the product composition on the labels of all dairy products and beverages analysed (100%) (Table 3). Individual allergens or PCIs in the product composition were listed after the phrase "may contain" on the labels of 6% of the products. On the labels of dairy products, allergens and PCIs were mainly presented in bold (94% of products) (Table 4). However, some labels combined bold text with a different font style (20% of products) and a different background colour for the text (2% of products).

About 100% of dairy products contained milk or its processed derivatives (Table 5). About 8% of dairy products listed soybean products as ingredients. In this product group, 6% of products listed nuts or traces of nuts (mostly without specifying the type of nuts). Dairy products also included cereal products (4%), egg products (4%), and peanuts (4%) (e.g., yogurt with crunchy balls). In the sauce and mayonnaise group, 22% of products contained 1 allergen or PCI, 20% contained 3 allergens or PCIs, and 16% contained 2 allergens or PCIs (Fig. 6).

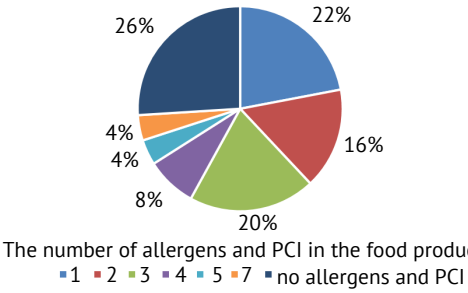

Figure 6. *Percentage of foods (sauces and mayonnaises) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

4 allergens or PCIs were listed on the labels of 8% of the products in this group. 5 allergens or PCIs were listed in the composition of 4% of sauces and mayonnaises, and the same percentage of products in this group contained 7 allergens or PCIs. However, 26% of the analysed products in this group contained no allergens or PCIs. These products were tomato sauces and ketchup. On the labels of sauces and mayonnaises that contained allergens and PCIs, they were mostly (83.8%) listed in the product composition (Table 3). However, on the labels of 54.1% of the products, allergens and PCIs were listed after the phrases "may contain" or "may contain traces of". In all sauces and mayonnaises containing allergens and PCIs, these were only highlighted in bold (Table 4).

The vast majority of sauces and mayonnaises (78.4%) contained mustard or its processed mustard products (Table 5). In addition, 59.5% of the analysed products in this group (mainly mayonnaises) contained eggs or egg products (e.g., egg powder), as stated on the label. Dairy products or the possibility of their traces were listed on the labels of 54.1% of the products. Soy products or soybeans were included in the composition of 24.3% of mayonnaise and sauces. Cereal products containing gluten were listed in the composition of 18.9% of sauces and mayonnaises, following the phrase "may contain traces of". Additionally, sauces and mayonnaises could contain traces of sesame (10.8%), peanuts (5.4%), nuts (2.7%), and celery (2.7%), as indicated on the label.

The cheeses analysed mostly contained 1 allergen or PCI (86% of products) (Fig. 7). Only 14% of the cheeses contained 2 allergens or PCIs. No cheese analysed contained more than 2 allergens or PCIs. Allergens and PCIs were listed in the product composition on the label of all cheeses (Table 3). On 6% of the cheese labels, the allergens or PCIs were listed after the legend "contains". Allergens and PCIs were listed after the phrases "may contain" and "may contain traces of" on the labels of 12% of the cheeses analysed. Allergens and PCIs were mostly highlighted in bold on cheese labels (74% of products) (Table 4), or in a combination of bold and capital letters (4% of products). Allergens and PCIs were only highlighted in capital letters on 12% of the product labels. A combination of bold and underlined text was used to highlight allergens and PCIs on 12% of cheese labels. On the labels of 22% of cheeses, none or some allergens and PCIs were highlighted. In particular, on the labels of some cheeses, whole cow's milk, skimmed milk, and milk powder were not highlighted in the product composition.

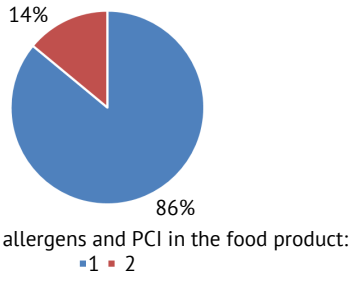

Figure 7. *Percentage of foods (cheeses) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

All the cheeses analysed (100%) contained milk or milk products (Table 5). The labels of 12% of the cheeses mentioned the presence of nuts (without specifying the type) or the possibility of their traces in the product composition. In addition, 2% of the products contained traces of celery, as indicated on the label. Among snacks, the largest number of products (24%) contained 4 allergens and PCIs (Fig. 8).

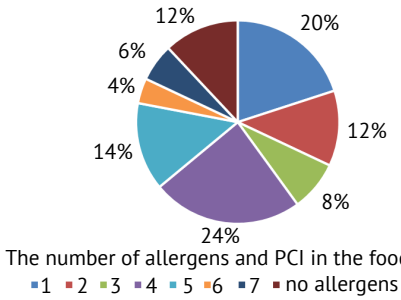

Figure 8. *Percentage of foods (snacks) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

Approximately 20% of snacks contained 1 allergen and PCI, while 14% contained 5 allergens and PCIs. A smaller number of analysed snacks contained the following: 12% contained 2 allergens and PCIs, 8% contained 3 allergens and PCIs, 4% contained 6 allergens and PCIs, and 6% contained 7 allergens and PCIs. Additionally, 12% of snack products contained no allergens; these included sunflower and pumpkin seeds and dried fruit chips. The labels of all the analysed snacks (Table 3) that contained allergens and PCIs reported the presence of these substances in the product. Additionally, on 61.4% of the snack labels, the presence of allergens and PCIs was indicated after the phrases "may contain" and "may contain traces of". On the vast majority of snack labels (84.1%), allergens and PCIs were highlighted in bold (Table 4). On 22.7% of snack packages, allergens and PCIs were highlighted using a different text style, and on 6.8% of packages, a different text style was combined with bold. The labels of 9.1% of products combined bold or another style with underlined text. There were also products, where allergens and PCIs were highlighted using underlined text only.

The analysed snack products contained almost all allergens and PCIs defined by the legislation of Ukraine, except for lupine and molluscs (Table 5). The largest proportion of snacks (70.5%) contained cereal products containing gluten (rye and wheat flour). Soybean products (e.g., hydrolysed soy protein, soy lecithin) were found in 63.6% of the snacks, as indicated in the ingredients list or following the phrase "may contain". In most cases, the label simply indicated "soy product". Additionally, 56.8% of snacks contained dairy products (e.g., whey powder, cheese powder, milk protein). A significant number of snacks (54.5%) also contained peanuts or peanut paste, or the label mentioned the possibility of peanut traces. Furthermore, 31.8% of snacks contained nuts or indicated the possibility of their traces, often without specifying the type. Egg products (e.g., egg powder) were listed on the labels of 20.5% of snacks. Additionally, some labels included the statement, "The product may contain a small amount of egg protein". Snack labels also informed consumers about the content, possible content in small amounts, and traces of the following allergens or PCIs: mustard (13.6%), sesame (6.8%), crustacean products (4.5%), fish products (4.5%), celery (4.5%), and sulphur dioxide without indication of concentration (6.8%). From 1 to 7 allergens and PCIs were identified in instant foods (Fig. 9).

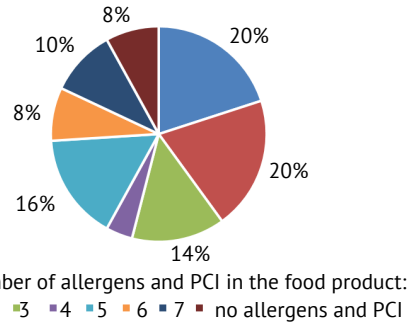

Figure 9. *Percentage of foods (instant food) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

20% of the products in this group contained 1 allergen or PCI, while the same percentage contained 2 allergens or PCIs. 7 allergens and PCIs were found in 10% of the products in this group. No allergens were found in 8% of the analysed instant foods, which were instant soups in briquettes, particularly those with rice and dried vegetables. In most cases (87% of products), allergens and PCIs were listed in the product composition on the labels of instant foods (Table 3). Additionally, allergens and PCIs were mainly listed after the phrases "may contain" and "may contain traces of" in 76.1% of product labels. Only 6.5% of instant food labels listed allergens after the word "contains". Allergens and PCIs were mainly highlighted in bold in 87% of product labels (Table 4). Capital letters were used to highlight allergens and PCIs in 28.3% of products, and another style of text was used in 2.2% of products. Furthermore, on 19.6% of instant food labels, capital letters were combined with bold text.

The vast majority of the analysed instant foods (93.5%) contained processed cereal products (Table 5) containing gluten (e.g., wheat flour). These products included, among others, instant pasta and noodles, soups with croutons, and mixtures of cereals from various grains. Dairy products were listed as an ingredient in 63% of the products, with most stating, "the product may contain a small amount of dairy products". Products such as instant mashed potatoes contained cream powder and milk powder. The labels of instant foods

often included the following information: may contain egg products (17.4%), mustard (10.9%), sesame (28.3%), nuts (34.8%), soy (39.1%), peanuts (23.9%), and traces of celery (26.1%). In some products (e.g., muesli), nuts, peanuts, and sesame were included in the recipe. The highest number of allergens and PCIs listed on a confectionery label was 5 (Fig. 10).

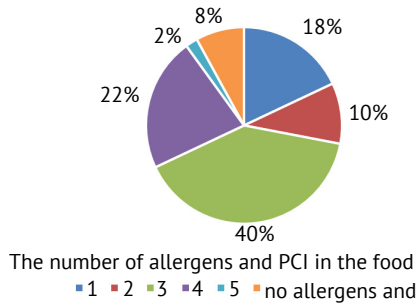

Figure 10. *Percentage of foods (confectionery) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

3 allergens or PCIs were listed on the labels of 40% of the products analysed in this group. 4 allergens or PCIs were listed in 22% of the confectionery products. 1 and 2 allergens or PCIs were listed in 18% and 10% of the products, respectively. No allergens or PCIs were listed in 8% of the confectionery products, mainly craft zefirs and marmalade. All allergens and PCIs were listed in the product composition on the labels of confectionery products. In addition, on the labels of 67.4% of confectionery products, allergens and PCIs were listed after the phrases "may contain" and "may contain traces of", while on the labels of 15.2% of products, they were listed after the word "contains" (Table 3). Allergens and PCIs were highlighted in bold on the labels of 89.1% of confectionery products, and in capital letters on the labels of 10.9% of products (Table 4). On the labels of 39.1% of products, allergens and PCIs were also highlighted in a colour different from the main text.

The most common ingredient used in the recipe of confectionery products that may cause allergic reactions was eggs or their processed products (mainly dried egg white). Eggs or egg-based products were included in the composition of 91.3% of the confectionery products (Table 5). In addition, 76.1% of the confectionery products (e.g. cakes, pastries) contained processed cereal products containing gluten (e.g., wheat flour). Milk and dairy products (butter, milk protein, skimmed milk powder, whey powder, cream, sour cream) were listed in 71.7% of the confectionery products. A soy product (soy lecithin) was listed in 15.2% of the confectionery products. Confectionery products also contained peanuts (6.5%) and nuts (6.5%). Sulphur dioxide was listed on the labels of 4.3% of confectionery products without specifying the concentration, mainly in the composition of semi-finished products (e.g., apple puree). The ice cream products analysed contained between 2 and 5 allergens or PCIs (Fig. 11).

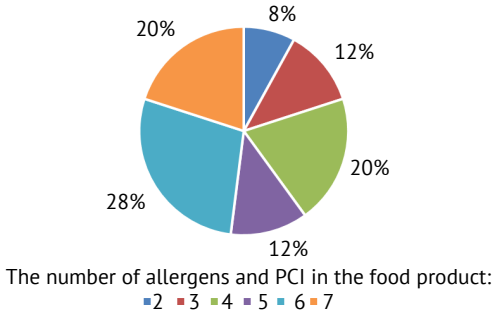

Figure 11. *Percentage of foods (ice cream) containing different amounts of allergens and PCIs*
Source: *developed by the authors*

28% of the ice creams contained 6 allergens or PCIs. 20% contained 4 or 7 allergens or PCIs, and 12% of the products in this group contained 3 or 5 allergens. Only 8% of the ice creams contained 2 allergens or PCIs. All allergens and PCIs were listed in the product composition on the ice cream labels (Table 3), and 60% of the products included the phrase "may contain" before the allergens. In most cases (92%), allergens and PCIs were highlighted in bold on the labels (Table 4). In addition, bold text was combined with capital letters on 4% of labels, and bold text was combined with another text style on 8% of labels. Allergens and PCIs were also highlighted by a combination of bold and underlined text on 4% of ice cream packs. A combination of bold text and a different shade of colour was used to highlight allergens and PCIs on 8% of ice cream packs. However, not all allergens and PCIs specified by Ukrainian legislation were highlighted on 8% of ice cream labels.

All the analysed ice creams contained milk or its processed products in their recipe (Table 5). The most frequently mentioned ingredients were cow's milk, skimmed milk powder, whey powder, butter, condensed milk with sugar, and milk protein. Soy lecithin was listed in the composition of 84% of ice creams. 76% of ice creams contained nuts, or it was stated that the product may contain nuts or their processed products. The most common nuts listed in ice cream were almonds, hazelnuts, walnuts, cashews, pistachios, and pistachio paste. Peanuts were included in the recipe of 64% of ice creams, either as a separate ingredient or with an indication that the product may contain them. About 72% of ice creams listed processed cereal products containing gluten. Wheat flour was used in ice cream recipes to make waffle cups, cones or plates into which ice cream was placed. Eggs and their derivatives, which were listed in the recipes of 52% of the ice creams, were also used to make waffle cups, cones or plates. Sesame seeds were listed on the labels of 40% of ice creams.

As noted by J. Muthukumar *et al*. (2020), public understanding of the potential consequences of consuming pre-packaged foods that trigger allergic reactions and intolerances remained limited. Therefore, consumer awareness of these consequences should be widely promoted. As proposed by S. Sansweet *et al*. (2024), an important component of reducing the risk of allergic reactions was educating all segments of the community, particularly in schools, so that individuals were aware of food allergen management issues and know, how to find the necessary allergen information on labels. It was also important to educate consumers of all ages about allergy prevention guidelines, food allergy diagnosing, and treating (Sampath *et al.*, 2021). F. Chang *et al*. (2023) recommended that individuals with food allergies pay close attention to the information on food labels, especially if it was unclear or ambiguous, and take precautions in places, where food was not labelled (e.g., restaurants, bars, airplanes, ships, and private gatherings).

Most of the analysed pre-packaged foods produced in Ukraine contained allergen and PCI labels on the packaging. Only 8.0% to 26.0% of products in the sauces, snacks, instant food, and confectionery categories did not include allergens or PCIs. Indicating allergens and PCIs on product packaging is an obligation of manufacturers in accordance with the requirements of Ukrainian legislation. As noted by B. Popping & C. Diaz-Amigo (2019), mandatory labelling of food allergens allowed consumers suffering from them to make informed choices. M.C. Lopez (2018) noted that most countries, including Ukraine, that regulate the declaration of allergens in pre-packaged foods used the list of allergens recommended by the Codex Alimentarius. International food standards (2025). Some countries have added other allergens or PCIs to this list based on statistical data on the causes of allergic reactions or product intolerance.

From 8% to 22% of the analysed products did not list allergens on the label, although they were present in the product composition. According to research by M.L. Cunha *et al*. (2020), 12.13% of the analysed foods in Brazil did not include the allergy alert. In the study, conducted in Lutsk (Ukraine), the highest proportions of such products were in the cheese category (22%) and milk-based ice creams (10%). This may be because manufacturers believed that consumers were aware that these products were made from milk or milk ingredients, and that the name of the product clearly refers to a specific substance or food item that was an allergen or causes intolerance.

According to research by N.B. Soogali & J.M. Soon (2018), most consumers believed that allergens should be highlighted in the ingredient list (e.g. in bold). This requirement was also included in the Ukrainian legislation. S. Doğan *et al*. (2023) found that consumers believed that allergy food labels would be more noticeable if symbols or bold text or both were used for labelling. The results of the analysis of pre-packaged foods showed that Ukrainian manufacturers highlighted allergens and PCIs on labels, mainly in bold (74-100% of products, depending on the food group). As noted by J. Choi & A. Choi (2016), consumers were also concerned about the font size of allergen information. They indicated that the font size should differentiate the food allergen information from the general nutrition information, which would improve PAL recognition. The study found that 4.0-28.3% of labels on Ukrainian products highlighted allergens and PCIs in a large font.

According to R. Baker (2018), such information on food labels made it difficult for consumers to distinguish between foods that pose a risk and those that do not. The use of PAL on food labels should be justified. Therefore, it was important that manufacturers assess the level of any unintended allergens present in their product and only use PAL, if the allergen level exceeds an agreed threshold (DunnGalvin *et al.*, 2019).

K.J. Allen *et al*. (2014) noted that PAL could be classified into 3 broad categories: "may contain", "produced on shared equipment" and "made in the same factory as". The statement "may contain traces of allergen(s)" was most common (Ontiveros *et al.*, 2020). This was also confirmed by the study by W.M. Blom *et al*. (2021), which found that for labels with a PAL, the most commonly used statement was "may contain traces of", with an overall score of 76%. H. Chafei *et al*. (2023) found that 42.9% of supermarket food products carried the precautionary allergen labelling "may contain traces of allergens". For the products of the analysed food groups of the Ukrainian manufacturers, such a PAL can be found on the labels of 6.0-76.1% of the products. At the same time, as noted by C.A. Marra *et al*. (2017), the use of precautionary statements, such as "may contain traces of peanuts", were the less important allergen-labelling attributes for consumers compared to the use of safety symbols and a safety statement (e.g., "does not contain soy, eggs or fish"). However, C.G. Mortz *et al*. (2024) noted that products labelled "may contain" do not provide consumers with information on whether the contamination was below their threshold for the specific allergen. Therefore, allergen labelling must be accurate and based on knowledge of threshold values for humans. Since lactose-containing products can also often cause allergies or intolerance that negatively affect the human body, ways to produce lactose-free products have long been studied. O. Shydlovska & A. Koiba (2023) noted that the production of lactose-free products was carried out using appropriate enzymes that help break down lactose. Accordingly, such products were easier to identify on store shelves.

According to a study by E. Mfueni *et al*. (2018), approximately 54.3% of food products carried a special allergen declaration in addition to the declaration in the list of ingredients. The analysis of food groups showed that most Ukrainian manufacturers, in addition to listing allergens or PCIs in the ingredient

list, also included them in a separate list following the word "contains" (6-36%).

The language, in which allergen information appeared on the labels of foods produced in different countries can be confusing to consumers, especially, if there wasn't translation of the label or if the translation is inaccurate. The labels analysed provided information on food composition and allergen content in Ukrainian. On some labels, this information was available in both English and Ukrainian. D. Seth *et al*. (2020) stated that the most common food allergens were eggs, milk, peanuts, tree nuts, soy, wheat, crustacean shellfish, and fish. In the food groups analysed, the most frequently detected allergens were products from processed cereals (gluten), eggs, milk, soy, peanuts and nuts.

This studies confirmed that the vast majority of Ukrainian food manufacturers comply with the requirements of Ukrainian law regarding the labelling of allergens and PCIs in food products. It used a variety of methods to indicate allergens and substances that may cause intolerance on the labels of packaged foods. This allergen labelling was in line with best practice in EU countries.

Conclusions

An evaluation of the characteristics of food allergen labelling in commercially available pre-packaged foods produced in Ukraine showed that manufacturers mostly comply with the requirements of Ukrainian legislation on allergen labelling. However, 22% of products in the cheese group, 10% of products in the bakery group, and 8% of products in the milk-based ice cream group were found to be lacking proper allergen or PCI labelling. This is probably due to the fact that the names of these products include an ingredient that is an allergen or PCI. In such cases, Ukrainian legislation allowed for allergens or PCIs not to be additionally indicated on the label. Food manufacturers prefered to highlight allergens or PCIs in the list of ingredients in bold, preferably black, as this meets the requirements of the legislation. Aware of the possibility of food cross-contamination with allergens or PCIs throughout the supply chain, including at primary production, during manufacturing, and at retail and food service endpoints, manufacturers additionally indicate allergens or PCIs that were not contained in the recipe on the labels using the phrases "may contain" or "may contain traces of". In this case, manufacturers typically indicated that the food product may contain traces of milk, eggs, nuts, peanuts, wheat (gluten), and soy.

Further research should focus on defining clear, acceptable levels of allergen content (thresholds) below which the risk of allergic reactions is minimised. It is also important to develop recommendations for indicating such levels for each allergen on labels, enabling consumers with allergies or intolerances to determine whether the product is safe for them.

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Conflict of Interest

None.

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Маркування алергенів та харчових продуктів, що викликають непереносимість, в Україні

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Анотація. Кількість споживачів із харчовими алергіями або непереносимістю швидко зростає у всьому світі. Законодавство багатьох країн, зокрема України, визначає перелік речовин і продуктів, що спричиняють алергічні реакції або непереносимість. Воно також встановлює вимоги до маркування алергенів на упаковках харчових продуктів, яких виробники повинні дотримуватись. Метою цього дослідження було визначити, як виробники харчових продуктів в Україні зазначають наявність речовин та інгредієнтів, що можуть викликати алергічні реакції та непереносимість, і чи відповідає таке маркування вимогам українського законодавства. Для аналізу маркування харчові продукти було згруповано у 10 категорій: ковбасні вироби, хлібобулочні вироби, печиво та вафлі, молочні продукти, соуси та майонези, сири, снеки, продукти швидкого приготування, кондитерські вироби та морозиво. Дослідження проводилося шляхом аналізу маркування харчових продуктів із місцевих супермаркетів у м. Луцьк, Україна. Було виявлено, що більшість проаналізованих продуктів містили алергени або інгредієнти, що спричиняють непереносимість. У різних категоріях від 8 % до 22 % харчових продуктів не мали належного позначення алергенів на етикетках, хоча вони були присутні. Українські виробники здебільшого використовували напівжирний шрифт для виділення речовин та інгредієнтів, що можуть викликати алергію або непереносимість (74,0-100,0 % продуктів). Лише 4,0-28,3 % етикеток продуктів використовували великі літери для виділення цих речовин та інгредієнтів. Виділення тексту кольором, стилем, фоном і підкресленням зустрічалося значно рідше і найчастіше поєднувалося з напівжирним шрифтом. Терміни «містить» і «може містити сліди» зустрічалися на етикетках 6,0-36,0 % і 6,0-76,1 % продуктів відповідно. Найпоширенішими інгредієнтами на етикетках аналізованих харчових продуктів були перероблені злакові продукти, що містять глютен, яйця, молоко або молочні продукти, перероблена соя, арахіс та горіхи. Результати аналізу показали, що українські виробники загалом дотримуються вимог українського законодавства щодо маркування речовин або інгредієнтів у харчових продуктах, які можуть спричиняти алергічні реакції або непереносимість

Ключові слова: алергія; захист споживачів; вимоги до маркування; розкриття інформації про інгредієнти; регуляторні стандарти