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FRONT-OF-PACK LABELING OF FOOD PRODUCTS: EVOLUTION, CHARACTERISTICS, CHALLENGES AND PROSPECTS

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Abstract. In the dynamic landscape of the food industry, front-of-pack labeling serves as a crucial tool for "dialogue" between producers and consumers. This mechanism helps to quickly and efficiently identify nutritional characteristics and serves as an effective tool for promoting healthy eating practices through an accessible and universal language. In this context, an exploratory study was conducted by analyzing scientific works on food labeling systems, including their evolution, the characteristics of different labeling typologies, the evaluation methods as well as the challenges and prospects for the development of food labels in the future. Each labeling typology had different attributes that represent an essential tool for supporting consumers in making food choices and in promoting a healthy lifestyle, both at the individual level and in terms of public health. To establish an integrated labeling system for food products, future research should focus on improving the universal applicability of labeled items and environmental sustainability, to make labels more digital and modern in the context of ongoing social and climate change.

Keywords: *front-of-pack labeling, nutritional labeling, nutritional quality, sustainability, sustainable agri-food systems.*

Rezumat. În peisajul dinamic al industriei alimentare, etichetarea frontală a ambalajului servește drept un instrument crucial de "dialog" între producători și consumatori. Acest mecanism ajută la identificarea rapidă și eficientă a caracteristicilor nutriționale și servește ca un instrument eficient pentru promovarea unor practici alimentare sănătoase printr-un limbaj accesibil și universal. În acest context, a fost realizat un studiu exploratoriu prin analizarea lucrărilor științifice privind sistemele de etichetare a produselor alimentare, inclusiv a evoluției acestora, a caracteristicilor diferitor tipologii de etichetare, a metodelor de evaluare cât și a provocărilor și perspectivelor de dezvoltare a etichetelor pentru produsele alimentare în viitor. Fiecare tipologie de etichetare a avut atribute diferite ce reprezintă un instrument esențial pentru sprijinirea consumatorilor în a face alegeri alimentare și în

promovarea unui stil de viață sănătos, atât la nivel individual, cât și în ceea ce privește sănătatea publică. Pentru a stabili un sistem integrat de etichetare pentru produsele alimentare, cercetările viitoare ar trebui să se orienteze pe îmbunătățirea aplicabilității universale a articolelor etichetate și a durabilității mediului, pentru a face etichetele mai digitale și mai moderne în contextul schimbărilor sociale și climatice continue.

Cuvinte cheie: *etichetare frontală, etichetare nutrițională, calitate nutrițională, durabilitate, sisteme agroalimentare durabile.*

1. Introduction

In recent decades, nutritional labeling has emerged as a crucial tool in promoting public health and combating the global epidemic of diet-related chronic diseases, such as type 2 diabetes, obesity, and cardiovascular diseases [1].

This increasing significance is reflected not only in public health policies but also in consumer preferences and behaviors, as individuals demand transparency and access to clear and concise nutritional information to make well-informed and evidence-based dietary choices [2]. In the dynamic landscape of the food industry, front-of-package labeling serves as a crucial communication tool between producers and consumers [3]. This mechanism helps in the quick and efficient identification of nutritional characteristics and other relevant attributes of food and serves as an effective tool for promoting healthy eating practices through an accessible and universal language [4]. The variety of labels reflects a wide range of objectives, from providing essential product information, such as organic status, ingredients, nutritional values and potential allergens, to effectively communicating health benefits [5,6].

Within the European Union, correct and detailed food labeling is a fundamental pillar in ensuring consumers' rights to be well-informed about the foods they consume [7]. By establishing strict and harmonized standards at the European level, Regulation (EU) No. 1169/2011 on food labeling aims to facilitate healthy and informed choices for consumers [8]. This regulation sets out consumer protection standards regarding information on food products, taking into account that these products will be marketed to different categories of consumers with diverse perceptions [9].

Consumers often face challenges in decision-making due to the overwhelming variety of food products available, each promoting different nutritional or health benefits. Front-of-package nutritional labels provide a summary of the nutritional profile, facilitating the quick identification of healthier food options [10]. Alongside the frameworks established by government bodies, associations in the food and beverage sector in Europe developed their own initiative, initially known as the "Recommended Daily Amount," which was later renamed the "Reference Intake Label." It is considered a good solution, offering an enhanced perception of the effect of diet on consumers' daily routines [11]. This innovation was implemented in 2006 and marked a pivotal moment in the evolution of nutritional information presentation on packaging.

A food product wishing to fall under this label must meet a set of specific nutritional standards, aligned with current public health directives. These rules focus on minimizing saturated fats, sugars, and salt, thereby encouraging producers to offer healthier nutritional alternatives [12]. Recent research highlights the significant influence of the "Reference Intake Label" on consumers' final decisions, enabling them to more clearly distinguish food products that promote a balanced diet [13,15,16].

1.1 Nutritional Labeling – History and Evolution

The evolution of labeling has been profoundly influenced by socio-economic, technological, political, and public health changes that have occurred globally. The earliest labeling practices began in the Roman Empire and were limited to marking wine amphorae to indicate their origin [17]. In the modern era, nutritional labeling serves not only as a guide for consumers but also as a public health policy to address nutritional issues on a global scale [18].

Early food labeling practices can be traced back to the Roman Empire, where the origin and quality of food products, such as wine and olive oil, were often indicated through markings on containers. These early labels, engraved on ceramic amphorae, signaled the geographic origin and suggested a level of quality or prestige associated with the region from which the products came. Although these practices did not directly focus on nutritional information as we understand it today, they represent the roots of the concept of traceability and authenticity of food [19].

Throughout the medieval period, concerns about food safety and authenticity continued to evolve. In medieval European cities, regulations concerning the quality of foods, such as bread and meat, were implemented to protect public health. These rules, often set by craft guilds, established production standards and could include inspection and marking of products to ensure compliance. In this context, labeling served more as a quality control mechanism than as an informational tool for consumers [20].

The transition to modernity marked a significant shift in labeling practices and food regulation [21]. In the 17th and 18th centuries, as the food trade became more complex and food products began traveling greater distances, the need for stricter and clearer regulations became evident and necessary [22].

In England, the "Assize of Bread" law of 1266 was one of the first attempts to standardize the quality of a food product by regulating the size and price of bread based on the cost of flour. This law represents an early example of governmental efforts to ensure the quality and accessibility of food for the population [23].

In the 19th century, the first legislations directly addressing labeling began to be adopted in various European countries. In 1860, the United Kingdom passed the Food Purity Act, which focused on combating food adulteration. Later, in 1924, the Food Labeling Act was introduced, establishing clearer and stricter requirements for food labeling. These laws played a crucial role in consumer protection, setting a precedent for the further development of food regulations worldwide [24].

In 1906, the United States passed the "Pure Food and Drug Act." This food regulation marked a crucial moment by prohibiting the sale of adulterated or falsely labeled food and beverages [25].

Another significant moment in the evolution of labeling was the introduction of food labeling laws in Germany during the early decades of the 20th century. These laws aimed to ensure transparency, prevent, and punish food fraud [26]. The approval of these laws imposed specific requirements regarding the listing of ingredients and nutritional values, marking an important step in the evolution of nutritional labeling [6].

The creation of the European Single Market marked a significant step in the economic and commercial integration of the European Union member states, removing trade barriers and facilitating the free movement of goods, including food products [27]. This integration had a profound positive impact on food labeling, requiring the harmonization of regulations to ensure transparency and consumer protection across all member states. The EU Directive

on nutritional labeling established common standards for presenting nutritional information on food products. A key milestone in this process was the adoption of Regulation (EU) No. 1169/2011 on the provision of food information to consumers [28]. This regulation required food labels to include essential details such as energy value, fat content, saturated fatty acids, carbohydrates, sugars, proteins, and salt. This contributed to a better understanding of the nutritional profile of food products by consumers. The EU's nutritional labeling policy significantly influenced national labeling practices, encouraging member states to adopt and implement EU standards into national legislation. As a result, nutritional information on food labels across the Union became clearer and more effective, facilitating consumer choices and promoting healthy and balanced eating.

As a former Soviet republic, the Republic of Moldova began the process of transition and reform in many sectors, including the food sector, after gaining independence in 1991. This transition involved adapting and modernizing legislation and regulations to address new economic and public health challenges. At the same time, it became necessary for Moldova to align with European standards and practices. Integration with the European market and the desire to move closer to the European Union motivated Moldova to adopt and implement European standards in food safety and nutritional labeling [29].

1.2 Front-of-package labeling systems for food products globally

Unhealthy eating is one of the leading causes of death and disability worldwide. On the other hand, humanity is facing a nutritional crisis: approximately three billion people in each of the 193 countries around the world, including the Republic of Moldova, consume foods that threaten their health due to high levels of potassium (salt), trans fats, and sugars [29-31]. The unprecedented availability and accessibility of processed and pre-packaged foods are key factors in obesity, non-communicable diseases, high blood pressure, cardiovascular diseases, type 2 diabetes, and even certain types of cancer, all of which are directly or indirectly linked to eating habits and behaviors. At the same time, governments are implementing and periodically revising front-of-package nutritional labels.

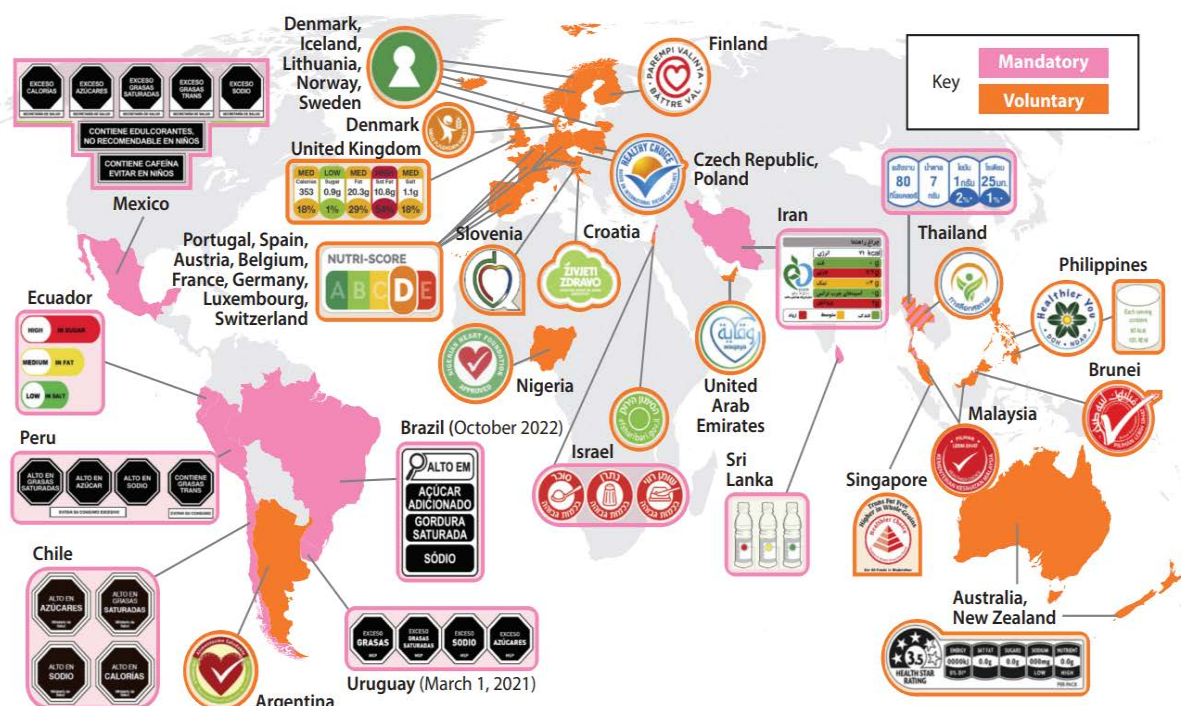


Figure 1. All countries with front-of-package food labeling systems [34].

These simple, often graphic labels provide at-a-glance information about the nutritional quality on the main display panel of food and beverages, complementing the detailed nutrient declarations on the back of the packaging. An increasing body of evidence suggests that such labels can help consumers understand nutritional quality, encourage the selection and purchase of healthier foods, and promote reformulation by the industry [32]. The application of front-of-package labeling systems globally is shown in Figure 1. Currently, 55 countries from Latin America, the Pacific West, and Europe voluntarily use various types of front-of-package food labeling [33]. At the same time, only in six countries is this system mandatory [14].

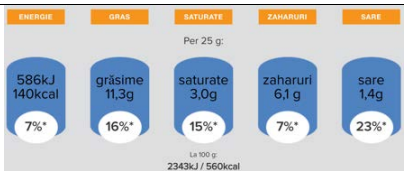
It is important to note that the implementation of front-of-package nutritional labels is associated with responses from food manufacturers. These responses depend on the label designs and the types of applications [35]. In addition, front-of-package labels contribute to encouraging product reformulation [36]. However, it is suggested that a mandatory approach be adopted globally, regardless of the label design, as it could have a significantly positive impact on public health [32].

1.3 Typologies and formats of front-of-package food labeling

In the dynamic landscape of the food industry, front-of-package labeling serves as an essential communication tool between producers and consumers [37]. This tool helps in the quick and efficient identification of nutritional characteristics and other relevant attributes of food. Additionally, front-of-package labeling serves as a vehicle for promoting healthier eating practices through an accessible and universal language. The diversity of labels reflects a wide range of objectives, from providing essential product information, such as ingredients, nutritional values, and potential allergens, to effectively communicating health benefits [38]. Several types of front labels indicating the title, the countries where they apply, and the image represented are presented in Table 1.

Table 1

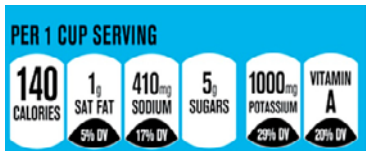
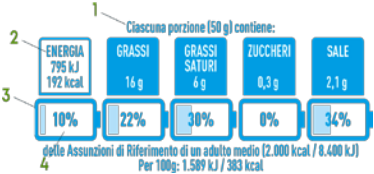
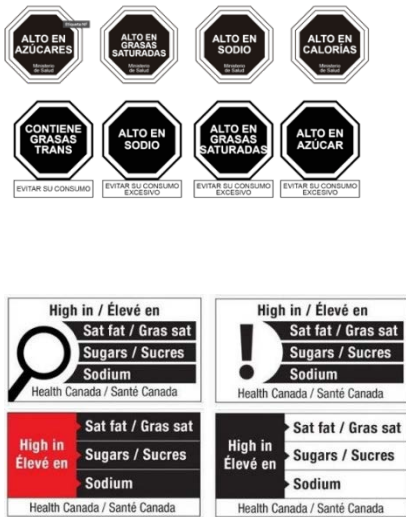
Types of front labels for food products

Front label name	Country where it is applied	Example images	Source
Reference Intake Label	UE		[39]
Nutri-Score	France, Belgium Spain, Germany Luxembourg Netherlands		[40]

Continuation Table 1

Keyhole	Sweden Norway Denmark Iceland Lithuania North Macedoni	 	[41]										
Choices Logo	Poland Czech Republic		[11]										
Finnish Heart Symbol	Finland		[42]										
Traffic Lights	UK	Each serving (150g) contains <table><tr><td>Energy 1046kJ 250kcal</td><td>Fat 3.0g LOW</td><td>Saturates 1.3g LOW</td><td>Sugars 34g HIGH</td><td>Salt 0.9g MED</td></tr><tr><td>13%</td><td>4%</td><td>7%</td><td>38%</td><td>15%</td></tr></table> of an adult's reference intake Typical values (as sold) per 100g: 697kJ/ 167kcal	Energy 1046kJ 250kcal	Fat 3.0g LOW	Saturates 1.3g LOW	Sugars 34g HIGH	Salt 0.9g MED	13%	4%	7%	38%	15%	[43]
Energy 1046kJ 250kcal	Fat 3.0g LOW	Saturates 1.3g LOW	Sugars 34g HIGH	Salt 0.9g MED									
13%	4%	7%	38%	15%									
Pick the Tick	Australia		[44]										
Evolved Nutrition Label (ENL)	UE	Each portion (250ml) contains <table><tr><td>Energy 57 kcal 242 kJ</td><td>Fat 0.7g</td><td>Saturates 0.3g</td><td>Sugars 1.6g</td><td>Salt 1.5g</td></tr><tr><td>3%</td><td>1%</td><td>2%</td><td>2%</td><td>25%</td></tr></table> of an adult's Reference Intake (R.I.) per 100ml: 97kJ or 23kcal	Energy 57 kcal 242 kJ	Fat 0.7g	Saturates 0.3g	Sugars 1.6g	Salt 1.5g	3%	1%	2%	2%	25%	[13]
Energy 57 kcal 242 kJ	Fat 0.7g	Saturates 0.3g	Sugars 1.6g	Salt 1.5g									
3%	1%	2%	2%	25%									
Health Star Rating	Australia and New Zealand	 <table><tr><td>ENERGY 1560kJ</td><td>SAT FAT 0.3g</td><td>SUGARS 1.5g LOW</td><td>SODIUM 5mg LOW</td></tr></table> PER 100g	ENERGY 1560kJ	SAT FAT 0.3g	SUGARS 1.5g LOW	SODIUM 5mg LOW	[45]						
ENERGY 1560kJ	SAT FAT 0.3g	SUGARS 1.5g LOW	SODIUM 5mg LOW										
Daily Intake Guide	Australia	<table><tr><td>ENERGY 870 kJ DI* 10%</td><td>PROTEIN 4.5 g DI* 9%</td><td>FAT 0.7 g DI* 1%</td><td>SAT FAT 0.3 g DI* 1%</td><td>CARBS 27.9 g DI* 9%</td><td>SUGARS 9.5 g DI* 11%</td><td>SODIUM 115 mg DI* 5%</td></tr></table> PER 60g SERVE	ENERGY 870 kJ DI* 10%	PROTEIN 4.5 g DI* 9%	FAT 0.7 g DI* 1%	SAT FAT 0.3 g DI* 1%	CARBS 27.9 g DI* 9%	SUGARS 9.5 g DI* 11%	SODIUM 115 mg DI* 5%	[46]			
ENERGY 870 kJ DI* 10%	PROTEIN 4.5 g DI* 9%	FAT 0.7 g DI* 1%	SAT FAT 0.3 g DI* 1%	CARBS 27.9 g DI* 9%	SUGARS 9.5 g DI* 11%	SODIUM 115 mg DI* 5%							

Continuation Table 1

Facts-Up-Front	USA		[47]
Smart Choices	USA		[48]
Heart-Check Mark	USA		[49]
NutrInform Battery	Italy		[50]
Warning Signs	Chile Uruguay Peru Canada		[51]

1.4 Food labeling in the EU

In the European Union, correct and detailed food labeling is a fundamental pillar in ensuring consumers' right to be well-informed about the foods they consume. By establishing strict and harmonized standards at the European level, Regulation (EU) No. 1169/2011 on food labeling aims to facilitate healthy and informed choices by consumers [52].

Alongside the frameworks established by governmental bodies, food and beverage associations in Europe developed their own initiative, initially known as the "Recommended Daily Amount," which was later updated to the name "Reference Intake Label." Implemented in 2006, this innovation marked a pivotal moment in the progress of presenting nutritional

data on packaging. Any food that wishes to fall under the umbrella of this label must meet a set of specific nutritional standards aligned with current public health directives. These rules cover limitations on saturated fats, added sugars, and salt, among others, encouraging manufacturers to provide more nutritionally advantageous options [53].

1.4.1 Reference Intake Label

The Reference Intake Label exerts a notable influence on consumer decisions, allowing them to easily distinguish food products that promote a balanced diet [31]. By explicitly displaying the contribution of each product to the suggested daily intake, consumers gain the ability to choose dietary variations that promote health. The design of the label (Table 1) focuses on a clear and accessible presentation, opting for an intuitive visual arrangement that summarizes data on calorie values and key macronutrients [31]. The foundations of this approach are rooted in the idea of transparency and education, providing consumers with the proper tools to make informed food choices [54].

This type of label plays a crucial role in promoting a healthy lifestyle, serving as a support point for those interested in enhancing the quality of their diet. At the same time, this label highlights the importance of recognizing the value of nutrition in maintaining overall well-being [55].

1.4.2 Nutri-Score Label

Among front-of-package nutritional labeling systems, Nutri-Score has marked a significant progress in public health and nutrition [56]. The Nutri-Score system originated in France, where it was introduced in 2017. This form of labeling is the result of extensive research in the fields of public health and nutrition [10]. After its implementation in France, the demonstrated popularity and effectiveness of the Nutri-Score system led to its adoption and expansion in other European countries. Belgium, Spain, Germany, Switzerland, and Luxembourg are among the countries that have adopted or expressed support for Nutri-Score, either as a voluntary system or through regulatory initiatives [57]. This expansion reflects the recognition of Nutri-Score's impact as a tool for improving public health by promoting healthy eating [58].

The Nutri-Score system serves as a visual guide for consumers, making it easier to quickly identify the nutritional quality of food products through a simple front-label. This system aims to tackle the rise of nutrition-related issues, such as obesity and malnutrition, by promoting healthier food choices [59].

The classification of prepackaged food products in the Nutri-Score system is based on an algorithm that evaluates both the content of nutrients and ingredients with potential negative effects on health (high calories, saturated fatty acids, added sugars, sodium, etc.) as well as those with health benefits (fruits, vegetables, nuts and legumes, fibers, proteins). The final score reflects a balance between these factors, classifying products from A to E [60].

The Nutri-Score label uses an intuitive combination of colors and letters to classify foods based on their nutritional quality. The system uses a scale from A (green, indicating the healthiest option) to E (red, indicating the least healthy option), making it easier for consumers to make informed food choices at a glance [61]. The color palette ranges from green (indicating the healthiest options) to red (indicating the options with the lowest nutritional quality), with intermediate categories in yellow, orange, and light red, providing a clear visual gradient to guide consumers in choosing healthier food options [62]. This color scheme facilitates quick recognition and assessment of food products. Each color category is

associated with a letter, from A (the healthiest) to E (the least healthy). The visual design of Nutri-Score (Table 1) is intended to be as accessible and easy to understand as possible for a wide range of consumers, regardless of their level of nutritional knowledge. The visual impact of the label aids in making informed decisions in a short amount of time, which is particularly valuable in crowded shopping environments [63]. It promotes nutritional transparency and encourages healthy choices through the simple visual scanning of available options. Research shows that Nutri-Score has a significant positive impact on consumer food choices. A study published in *Public Health Nutrition* found that the presence of the Nutri-Score label on food packaging can prompt consumers to choose healthier options, compared to the absence of a nutritional label or the presence of other types of labeling [64]. This effectiveness is likely due to the intuitive and easy-to-understand design of the system, which facilitates quick comparisons between different food products at the time of purchase. A study conducted in France showed that the presence of Nutri-Score on food packaging increased consumers' selection of foods with a superior nutritional profile [65].

In conclusion, Nutri-Score is a valuable tool in the arsenal of strategies aimed at improving public health through the promotion of healthy eating. However, its continued success depends on ongoing research, adaptation, and implementation efforts that take into account the diversity and complexity of nutritional and dietary needs globally [66].

1.4.3 "Keyhole" label

The "Keyhole" label (Table 1) was created with the goal of guiding consumers towards healthier food choices, emphasizing the identification of products with lower content of fats, sugar, dietary fiber, or salt [67]. This front label was created in 1989 in Sweden by the Nordic Council of Nutrition and Food and has been essential in promoting a balanced diet [68]. The Keyhole symbol has a distinct shape, resembling a stylized key with a hole in the center, which is where the name "Keyhole" comes from, symbolizing the opening to a healthy life [69]. The color can be either black or green, but the dominant color is often green. This color symbolizes the freshness and naturalness of healthy foods [70]. The emblem must be accompanied by the ® symbol, and its structure must comply with the requirements outlined in the "Design manual for the Keyhole logo" [71].

The label generally applies to food products that meet specific nutritional criteria, such as:

- limiting sugar;
- low fat content;
- higher content of dietary fiber and whole grains;
- control of potassium (salt) [72].

In conclusion, the Keyhole label stands out by not requiring advanced knowledge in nutrition or high intelligence to be understood. Its simple nutritional labeling system, placed visibly on the front of the packaging, is designed to be accessible and easy for consumers to use when selecting a product. This aspect helps facilitate the process of choosing healthier food products, while promoting quick and efficient understanding of essential nutritional information. In essence, this symbol facilitates the adoption of positive eating habits, reflecting a commitment to a more informed and healthier society [73].

1.4.4 "NutrInform Battery" label

The "NutrInform Battery" label is attributed to a relatively recent innovation in nutritional labeling. It offers consumers an intuitive visual method for evaluating the

contribution of a food product's serving to the recommended daily intake of nutrients. This type of label made its debut at a time when the demand for transparency in food labeling grew exponentially. The "NutrInform Battery" was designed to meet the need for a quick and intuitive understanding of the intake of essential nutrients, providing consumers with vital information through a memorable visual that supports them in making informed dietary decisions [74].

The design of the "NutrInform Battery" label is distinct and intuitive, using the analogy of a battery (Table 1) to visually communicate the level of energy and nutrients provided by the product, in the context of the recommended daily intake. This design choice aims to improve informational ergonomics, facilitating the immediate and intuitive interpretation of essential nutritional data on the front label. "NutrInform Battery" is assigned to front labels that simplify and significantly influence the decision-making process at the point of purchase, offering an easy-to-understand graphic representation of nutritional information [75].

The impact of the "NutrInform Battery" label on consumer behavior is a topic of interest in the fields of human nutrition and public health. Studies and research conducted so far suggest that this label has significant potential and significantly influences both purchasing decisions and the nutritional awareness of consumers [76].

Following the analysis of the "NutrInform Battery" label, we conclude that this label represents a step forward in the evolution of nutritional labeling, achieving the goal of making nutritional information accessible to consumers in an intuitive and immediately interpretable visual format. Through the battery symbol, the label quickly conveys a food's contribution to the daily recommended intake of energy and nutrients, thus supporting a well-founded and conscious food decision-making process.

1.4.5 "Choices Logo" label

The "Choices Logo" concept was initially developed in the Netherlands as a voluntary labeling system aimed at identifying food products that meet specific nutritional standards set by an independent scientific committee [77]. The goal of using this type of label is to provide consumers with a simple and direct method of recognizing healthier food options on store shelves. The main objectives of the "Choices Logo" label focus on promoting public health and educating consumers on nutrition [78]. The "Choices Logo" label aims to:

- Help consumers make healthier food choices: By providing a clear and visual way to identify products that meet strict nutritional standards.
- Promote a healthy lifestyle: By encouraging the consumption of nutritionally balanced food products, thereby contributing to the reduction of public health risks.
- Support nutritional education: By offering accessible information to consumers to help them understand the importance of food choices and their long-term health effects.
- Facilitate the quick recognition of healthy food options: Ensuring that products labeled with the "Choices Logo" are easy to identify on store shelves, saving consumers time and effort.
- Contribute to reducing the risks associated with unhealthy eating: By making healthier products more visible and accessible, the label can support a reduction in diseases related to an unbalanced diet, such as obesity, diabetes, and cardiovascular diseases [79].

The design of the "Choices Logo" label incorporates strategic visual elements to effectively communicate the nutritional benefits of food products to consumers. Analyzing

the design of this label reveals a careful use of symbolism, color, and placement, each of these aspects being crucial in facilitating quick recognition and understanding of its message [80].

2. Authorized methods with reference to the evaluation of food labelling

"Authorized Methods for Labeling Evaluation" refers to a set of official, standardized procedures and techniques employed to assess the accuracy, effectiveness, and compliance of food labeling with regulatory requirements [81]. These methods are designed to ensure that food labels provide clear, truthful, and reliable information to consumers, thus aiding in informed decision-making and promoting public health [82]. The evaluation of food labels involves several scientific approaches, such as chemical analysis, sensory testing, and expert review. These methods help verify nutritional content, ingredient lists, allergen declarations, and any other claims made on the label. To ensure the reliability and consistency of labeling practices, these methods are often authorized by regulatory bodies such as the European Food Safety Authority (EFSA), the U.S. Food and Drug Administration (FDA), or other national and international standardization organizations [83].

Key components of authorized methods for labeling evaluation include:

Nutritional Analysis. This involves laboratory testing to verify the nutritional composition of food products, ensuring the accuracy of caloric, macronutrient, micronutrient, and other nutritional claims made on labels. For example, food may undergo testing for its levels of vitamins, minerals, sugars, fats, proteins, and other key components.

Sensory Analysis. This is the evaluation of food labels in terms of consumer understanding and appeal. It includes testing how well the label communicates essential information through design, colors, and the choice of terminology, ensuring clarity and ease of use for the general population.

Regulatory Compliance Checks. Authorized methods also involve verifying that the food labeling complies with the established legal frameworks, such as those set forth by Codex Alimentarius, the FDA, or the European Union regulations. This includes checks for mandatory nutritional declarations, allergen warnings, and appropriate health claims.

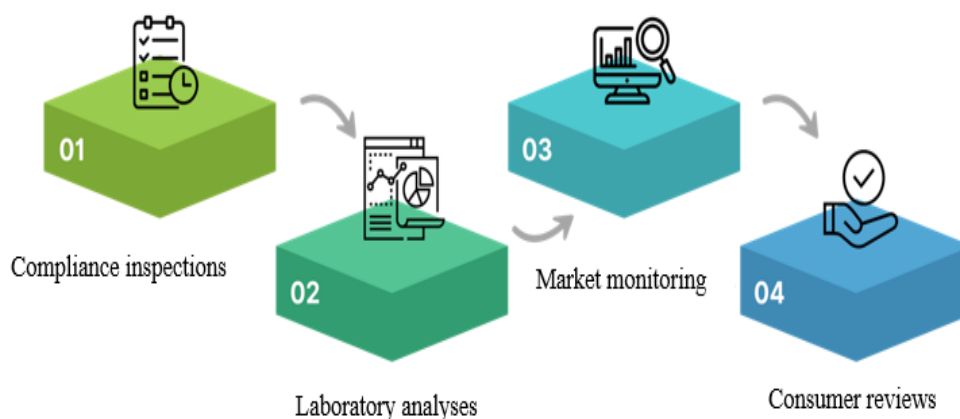


Figure 2. Authorized Methods for Labeling Evaluation.

Technological Assessments. With advancements in digital labeling, methods for evaluating the accuracy of QR codes, smart labeling systems, and other digital methods have emerged. These technologies must also be evaluated to ensure that they meet current standards and provide consumers with accurate, accessible information.

Consumer Feedback and Behavior Analysis. Some authorized methods involve assessing consumer reactions to labeling formats and claims through surveys and market

research. Understanding consumer behavior helps refine labeling strategies to better serve public health goals.

Overall, the goal of authorized methods for labeling evaluation is to safeguard consumers by ensuring that food labels are accurate, clear, and compliant with regulations. These methods are essential for maintaining transparency in the food industry, supporting healthier consumer choices, and contributing to the broader objectives of public health and nutrition.

Competent authorities conduct regular inspections at food producers and distributors to ensure that labeling complies with the applicable regulations (Figure 2). These inspections include verifying product labels on-site or in authorized laboratories to confirm the accuracy of the declared information. To validate nutritional information and check for the presence of allergens mentioned on the label, laboratory analyses are performed. These tests are essential to ensure the accuracy of the data presented to consumers.

3. Authorized methods with reference to the evaluation of food labelling

It is evident that the packaging and labeling of food products are continuously improving [84]. This responds to the current demands for foods that need to be as fresh as possible, easily preserved, convenient, delicious, safe, healthy, and with a longer shelf life [85]. Innovations in packaging are a tool for increasing the global sustainability of food production and reducing losses and food waste caused by expiration dates [86,87]. Despite the current success of labeling, further research is needed to meet market demands [88]. Technology and cost-effectiveness are the main constraints in the development of packaging labels. Labels involve complex technology, limited basic research, and high production costs, which can account for, in some cases, about 10-20% of the total packaging cost [89].

It is worth mentioning that today, mobile networks such as 4G and 5G, cloud storage, large data platforms, smart homes in supermarkets, and others are gradually gaining popularity. Food product labels display information about products and anti-counterfeiting functions. Specifically, labels also have the function of a "dialogue" with the consumer. Different types of food front labels are constantly emerging, but the application of labels must respond to their fundamental purpose and objectives, while also being environmentally friendly. To establish an integrated labeling system for food, future research should focus on improving the universal applicability of label items and environmental sustainability, in order to make labels more digital and modern [90].

With all the aforementioned, there are various challenges that need to be addressed to ensure the efficiency and relevance of this information system. In the following, we will analyze the main challenges and future perspectives of food labeling.

The most relevant challenges are:

1. **Diversity of international regulations and standards.** Food labeling varies significantly from one country to another, and differences in legal regulations and nutritional standards can complicate the process of understanding labels by consumers, especially for international products. Harmonizing regulations at the global level remains an ongoing challenge.

2. **Complexity of labels.** Food labels are often overloaded with information that can become confusing for consumers, especially for those without advanced knowledge of nutrition. This complexity can lead to a misunderstanding of the nutritional value of the product.

3. **Accessibility and language of labels.** The use of technical language and complex nutritional concepts can pose a barrier for many consumers. Additionally, it is important for labels to be accessible to people with visual impairments or reading difficulties.

4. **Marketing of processed products.** Many processed food products are often marketed as healthy, even though they may contain high levels of sugars, saturated fats, or salt. Labeling can be misused to mask these deficiencies, presenting a challenge for consumers to make informed choices.

5. **Lack of a universal label.** Currently, there is a wide variety of nutritional labels (Nutri-Score, Keyhole, etc.), and consumers may become confused due to the lack of a universally standardized system at the global level. While some labels are well-received, others may be misunderstood or ignored.

Some **perspectives** for the future are presented below:

1. **Harmonizing global regulations and standards.** It is essential for countries and international organizations to work towards harmonizing regulations regarding food labeling. A globally standardized system would help reduce confusion and facilitate informed consumer choices.

2. **Promoting clear and visible front-of-pack labels.** Front-of-pack nutritional labels, which provide clear and concise information about the nutritional value of a product, are likely to gain more popularity. Labels such as "traffic light" or those with visible scores (e.g., Nutri-Score) can help consumers quickly identify healthier food options.

3. **Educating consumers and developing nutritional knowledge.** The future of food labeling will not only focus on improving the design of labels but also on nutritional education. Teaching consumers about the importance of reading labels and understanding the nutritional value of products will support the adoption of healthier eating habits.

4. **Technology and digital labeling.** Technology is playing an increasingly important role in food labeling. Digital labels or mobile apps can help consumers access detailed information about food products by scanning QR codes or other forms of encoding. This innovation will allow for the rapid updating of information and help consumers make better choices.

5. **Stricter monitoring and regulation.** In the future, authorities will need to continue to monitor and regulate the food industry more strictly to ensure that labeling complies with legal regulations and that there are no deceptive practices. This will help prevent abuses and encourage transparency in the food industry.

4. Conclusions

Nutritional labeling has become an essential element in promoting public health and guiding consumers toward well-informed and reasoned food choices. Throughout history, various types and formats of front-of-pack labeling have been developed, highlighting different approaches such as "Nutri-Score," "NutriInform Battery," and "Keyhole," among others, all aimed at providing consumers with quick and useful information about the nutritional content of foods, thus facilitating healthy choices.

In the Republic of Moldova, nutritional labeling regulations align with European standards, conforming to the recommendations of the World Health Organization and Codex Alimentarius, thereby contributing to consumer protection and the promotion of healthy eating. The authorized methods for evaluating food product labeling, as well as the

involvement of specialized and related organizations, ensure the quality and accuracy of the information provided to consumers.

Overall, food labeling plays a crucial role in guiding consumers toward healthy food choices, serving as an essential tool in promoting public health. The diversity of labeling types, from "Reference Intake Labels" to "Warning Signs," highlights global efforts to provide consumers with the necessary tools to support their understanding of the nutritional complexity of foods. This complexity requires a multidisciplinary approach, encompassing not only nutrition science but also consumer psychology, communication design, and health policy.

For nutritional labels to be effective, they must evolve alongside knowledge and nutritional trends. Global collaboration and legislative adaptability are essential to ensure effective nutritional labeling in a globalized world. In this context, nutritional labeling represents a vital tool for supporting consumers in making healthy food choices and promoting a healthy lifestyle, both on an individual level and in terms of public health.

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