Charis M. Galanakis *Editor*

The Age of Clean Label Foods

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Preface

Nowadays, consumers are more and more interested in processing, origin, health concerns, and ingredients of the food products. These consumer demands are leading food and beverage manufacturers toward developing new products by removing synthetic additives (e.g., emulsifiers) and at the same time incorporating natural ingredients. In response to consumer demands, the food industry has recently been directed to "clean label" products, having fewer additives. This trend is promoted with the general term "clean label" without any formal definition. However, due to its high market appearance and industrial relevance, "clean label" has become a trendy concept for the food sector leading to innovations in food product development. To this line, many big food companies have committed to removing artificial food additives, and subsequently formulating products with simple labels using recognizable ingredients is a growing commercial necessity. Nevertheless, the substitution of chemical preservatives with natural ingredients is a challenge for food technologists as synthetic additives extend the shelf life at a low cost. Besides, the safety, convenience, and sensory characteristics of the food products should not be compromised.

Food Waste Recovery Group (www.foodwasterecovery.group) has developed different initiatives, including consultation reports, workshops, reference modules, webinars, e-courses, publications, and multiple books in the broad fields of agricultural sciences, bioresources, food, and environment. Following the above considerations, our group has developed a new book that fills the gap existing in the current literature by providing information with regard to the incorporation of "clean label" ingredients in foods as well as the development of respective products. The final goal is to support the current industrial efforts and market applications.

The book consists of seven chapters. Chapter 1 comprises an introduction to the book by giving an overview of food labeling regulations and discussing relevant definitions of "Clean Label" and related terms, industrial activities, and relevant challenges. "Clean Labeling" is an initiative driven by consumer demands regarding easily understandable food labels and foods containing natural and familiar ingredients and free from additives. However, although food businesses acknowledge such demands and are increasingly developing "Clean Label" products, it is essential to

note that there are no generally accepted standards for "Clean label." Other related terms include, for instance, certified organic foods, free-form, and no-additives, among others.

Emulsifiers are essential food additives with the ability to stabilize the foods comprising immiscible phases. In addition to this, they perform several other functions like lubrication, crystal modifier, texture enhancer, shelf-life enhancer, moisture barrier, etc. Chapter 2 provides details about various natural emulsifiers, their origins, and possible applications in multiple foods, pharmaceutical and cosmetic products. The behavior of different emulsifiers (e.g., proteins, polysaccharides, phospholipids, and bio-emulsifiers) toward interface and factors affecting (pH, ionic strength, temperature) their functionality as well as emulsion stability are also discussed in this chapter.

Synthetic food additives have long been used in the food industry to ensure oxidative stability, increase shelf life, or impart a specific flavor to foods. However, their potential links to human health risks are discussed among the consumers. Chapter 3 addresses the latest findings on the natural antioxidants and flavorings for clean label foods. It will also discuss the food safety and food structure (sensory) challenges that need to be taken into consideration when "chemicals" are replaced with "natural" ingredients in food and beverage production.

Lipids are an essential component of our daily food intake; however, their overconsumption has been associated with obesity and increased risk of diabetes, coronary heart disease, and certain forms of cancer. Fats are also responsible for many high-quality attributes in foods, mainly related to texture, stability, taste, and aroma. In Chap. 4, clean label ingredients to replace fat in foods, including fat substitutes and fat mimetics, are discussed. A description of different clean label reduced-fat foods as sauces and bakery, meat, or dairy products is provided as well.

Over the last years, there has been extensive research on aqueous foams. However, with time non-aqueous foam started to gain popularity in research work due to its favorable attributes since health-conscious consumers tend to consume products with reduced saturated fats. Chapter 5 provides a concise overview of the new promising areas in food science with a focus on the stability of oil foams, mainly formed by surface-active colloidal particles, as well as the factors (time, temperature, cooling rate, shear rate, and contact angle) affecting the ole foam stability. The critical role of ole foam in manufacturing unique texturized food products with less saturated fatty acids and improved mouthfeel is also discussed.

Traditional plasticizers are used for packaging purposes in order to keep the food quality over extended periods, but at the same time, they generate potential health and environmental issues. The development of clean label or bio-based food packaging materials (which are nontoxic and free from any chemical) has been suggested as an alternative strategy. Chapter 6 discusses clean label interventions in active and intelligent food packaging, giving emphasis on cost-effective and reliable bio-based and antioxidant-rich solutions.

The need for transparency in health and food safety always confronts customers with questions such as product content, the origin of production, production processes, additives used, and the status of ethical factors in the production process. To

this line, investigating the relationship between consumers' behavior and the clean label of food products is crucial for both consumers and food producers. Chapter 7 deals with consumer behavior upon clean label products, revising the most undesirable ingredients for consumers in the composition of products. Thereafter, it presents modern methods to detect food fraud and to mislabel, prior to exploring different uses of nontraditional raw materials in food products and discussing the main principles of creating attractive consumer products.

Conclusively, the current book assists food technologists, scientists, engineers, and chemists activated in the food science field, but also professionals working in the food industry. It also concerns food industry employees, researchers working with food applications and food processing, as well as professionals and those who are interested in the development of innovative food products. It could also be used by academic institutes all around the world as a textbook and ancillary reading in undergraduates and postgraduate level multidiscipline courses dealing with food science and technology.

At this point, I want to take this opportunity to thank all the authors of this book for their high-quality work in bringing together important aspects of clean label foods. Their acceptance of editorial guidelines, collaboration, and dedication to the book's concept is highly appreciated. I would also like to acknowledge the book manager Sofia Valsendur and the acquisition editor Daniel Falatko. Last but not least, those collaborative efforts contain hundreds of thousands of words and could contain some errors. This is why constructive comments and even criticism are always welcome, so please do not hesitate to contact me to propose any changes.

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Chapter 1
Introduction

Marina Cano-Lamadrid, Juan Miguel Valverde, Leontina Lipan, Ángel Antonio Carbonell-Barrachina, and Esther Sendra

1.1 Concepts Related to "Clean Label" and State of the Art in Scientific Production

1.1.1 Definition

Nowadays, the concept of "Clean Label" is a priority for food and beverage companies, but it is an unregulated and undefined descriptor. Due to the lack of legal definitions and specific regulations (Busken 2015; Varela and Fiszman 2013), the interpretation of "Clean Label", in particular some terms such as "artificial" and "natural" ingredient, is subjective both to consumers and food companies. What is more, definitions depend on the party involved (food and beverage manufacturers, ingredient suppliers, retailers, and consumers), each having their definitions of the meaning of "Clean Label". It seems that consumers' interpretation is the most important one if they repeatedly purchase the product (Katz 2011).

Several definitions and interpretations of "Clean Label" have been proposed by market trend reports and scientific literature as follow:

Marina Cano-Lamadrid and Juan Miguel Valverde contributed equally with all other contributors.

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- Borra (2010) suggests that "Clean Label" involves not only ingredient statement, but also the company's sustainability (source of raw material, production conditions and processing, including how it gets to stores and homes) (Borra 2010).
- Roller (2010) defines it as those present the following claims: "all natural", "organic", "no antibiotics", "no-GMO ingredients", "free range", "locally grown". These concepts influence the consumer opinion about if the product presents a "Clean Label" or not (Roller 2010).
- Rozin et al. (2012) says that consumers tend to define natural foods as those with fewer additives and alterations, which might be a "Clean Label" (Rozin et al. 2012).
- Busken (2015) and Varela and Fiszman (2013) mention that a "Clean Label" is characterized due to the lack of ingredients that induce contradiction in the ingredient list such as allergens, and additives others. It includes ingredients perceived as natural, harmless, and simple which consumers know and use them (Busken 2015; Varela and Fiszman 2013).
- Varela and Fiszman (2013) defines "as being produced free of 'chemicals' and additives. Also, as formulating with familiar ingredients, and being produced by using traditional technologies" (Brockman et al. 2013).
- Hutt and Sloan (2015) define a "Clean Label" as that in which natural ingredients are listed, or no high fructose corn syrup and artificial ingredients, preservatives, and colorants are used in food processing (Hutt and Sloan 2015).
- Lefferts (2017) mentions that "Clean Label" is usually interpreted as food products with short-ingredient list, without synthetic chemicals, and with understandable and familiar ingredients (Lefferts 2017).
- Cargill (2017) explains that a "Clean Label" is based on a shorter and simple ingredient list containing as less processed ingredients as possible. It should not include chemicals and E-numbers elements (Cargill 2017).
- Asioli et al. (2017) indicated that "Clean Label" should be understood as a product in which ingredient list is distinguished by several specifications such as short- and simple-ingredient list, with no synthetic and familiar ingredients. Also, they are, among other things, defined by 'free from', and a multifactor item, including environment and sustainability (Asioli et al. 2017).
- Aschemann-Witzel et al. (2019) indicate that it is referred to as a food product with minimally processed ingredients defined by 'natural' and 'free from'. They are based on the perception of consumers which classify ingredients depending on appearing natural (favorable) and un-natural (avoided) (Aschemann-Witzel et al. 2019).
- Ingredion (2020) specify that the meaning depends on the point of view. As to consumers, a "Clean Label" means a food product as 'natural', 'organic' and/or 'free from additives'. Regarding producers, it spells food products in which consumers widely accept ingredients. Therefore, the ingredient list may include short, simple and little processed ingredients. Also, no-including chemicals and E-numbers (codes for additives in the European Union) in the ingredient list is recommended (Ingredion 2020).

Taking all the definitions mentioned above into account, it can be said that the interpretation of a "Clean Label" is not objective. It depends on the familiarity of the consumer with the food ingredients and/or production method. Additionally, it does not exist a specific place in the supermarket dedicated to clean-label foods, and it is also not seen the words "Clean Label" on the product label. However, what is clear is that most of the definitions agree that a "Clean Label" must contain a short and simple ingredient list, and words such as natural, organic, or free from additives. On the other hand, words that sound like chemicals or E-numbers must be avoided.

Table 1.1 shows the terminology related to "Clean Label", some of the most common terms are defined in Fig. 1.1.

Based on scientific literature, the origin of "Clean Label" is shown in Fig. 1.2. First of all, "free from" claim seems to be the basis of "Clean Label" trend, specifically "GMO free".

Additionally, Fig. 1.3 shows the evolution of "Clean Label" trend, including E-numbers, non-GMO, organic, natural, and simple ones.

Consumers demand foods which are more natural and organic, and minimally processed. What is more, 'free from' or 'no-' allergens and/or additives are demanded (Ingredion 2020). Conceptually, terms such as health and sustainability motive the current trends on the food market. It is essential to indicate that the consumer expectation mainly is to consume more plant-based food products. Therefore, manufactures are focused on offering "Clean Label" foods (Aschemann-Witzel et al. 2019). Several food companies are including claims such as 'Free from' synthetic colorants, flavorings, and additives. 'Natural ingredients' are other example food companies include promoting "Clean Label" products. The desire to find food products more natural is due to the increasing demand for these types of products.

Generally, consumers avoid ingredients that are not ease to pronounce (Song and Schwarz 2009) or unfamiliar (Moskowitz et al. 2012) since those ingredients are unhealthy. Similarly, Dickson-Spillmann et al. (2011) studied the risk perception of chemicals on the consumers' attitudes by chemical and synthetic ingredients. Those ingredients' presence increased the risk perception, while the risk perception was positively correlated with the natural foods tendency (Dickson-Spillmann et al. 2011).

Clean Label is a global megatrend, expanding into new segments and geographies. The COVID-19 epidemic has increased consumer's consciousness on health and well-being. The consumer is more connected, informed and more concerned about their purchase decisions on themselves, their family and the environment (Ingredion 2020).

Moreover, it is essential to highlight that consumer expectation on Clean Label presents three cores. These translate that a product with a "Clean Label" must contain: (a) a natural, familiar, and simple ingredients list; (b) nutrient-dense ingredients; and (c) produced sustainably, considering animal welfare, without compromising the needs of future generations.

Table 1.1 Concepts included in "Clean Label" definitions from several sources. Numbers in brackets are the sources of definitions listed in the reference list

	Terminology	2010 (4)	2010 (5)	2012 (6)	2013 (1)	2013 (2)	2013 (7)	2015 (8)	2017 (9)	2017 (10)	2017 (11)	2019 (12)	2020 (13)
To include	Sustainability/ environment	X									X		
	Raw material	X											
	All natural/natural		X	X	X	X		X				X	X
	Organic		X										X
	No antibiotics		X										
	No-GMO		X										
	Free/free from/no		X				X	X			X	X	X
	Simple				X	X				X	X	X	X
	Traditional						X						
	High-fructose syrup							X					
	Shorter ingredient list								X	X	X		X
	Accepted by consumers												X
	Locally grown		X										
To avoid	Artificial							X	X		X		
	Allergenic				X	X							
	Additives/E-numbers			X	X	X	X			X			X
	Industrially				X	X				X		X	X
	Unfamiliar				X	X			X		X	X	
	Chemical sounding				X	X	X		X	X	X		X
	Synthetic								X				
	Preservatives												X

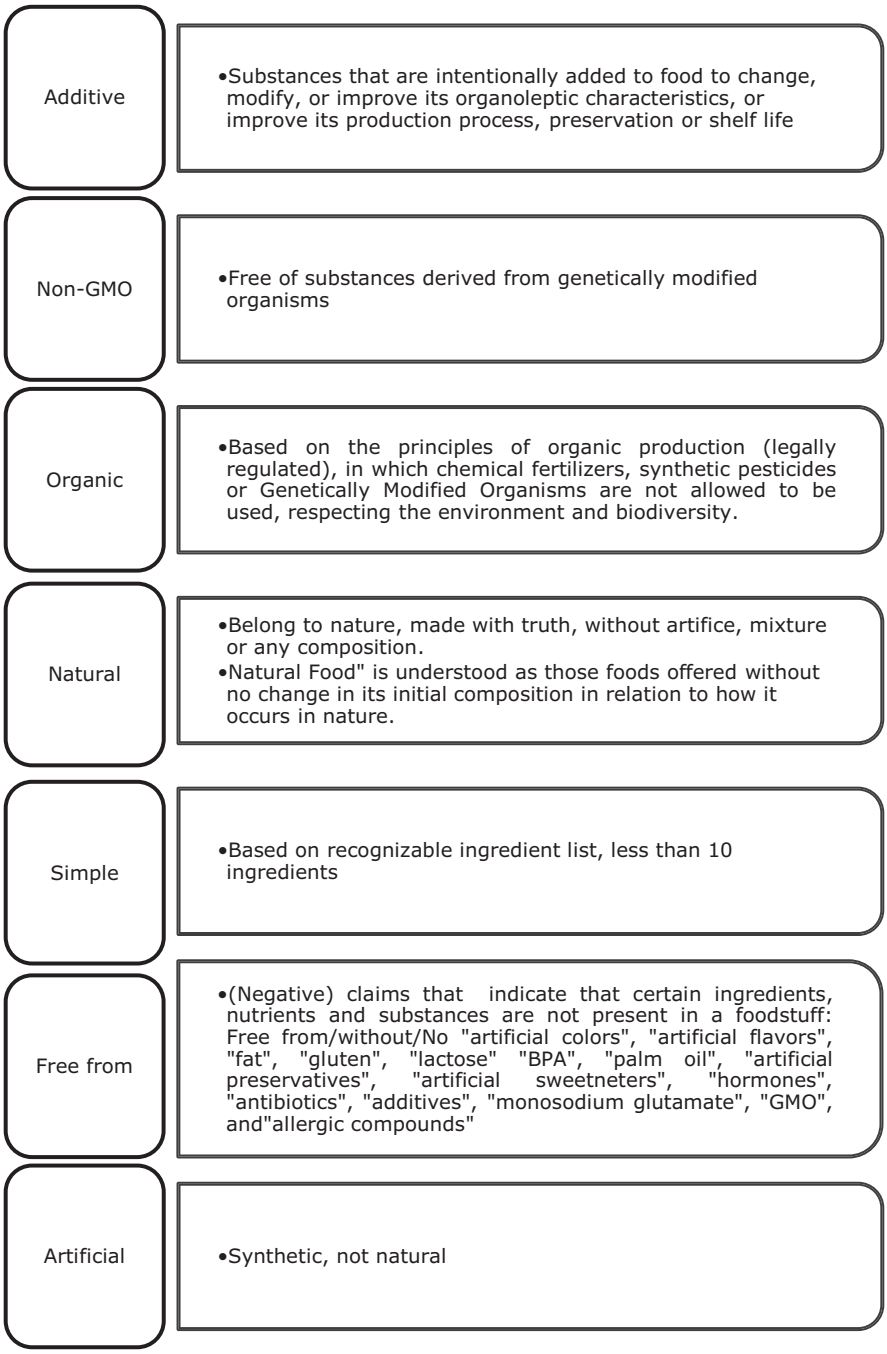

Fig. 1.1 General definitions of concepts related to “Clean Label”

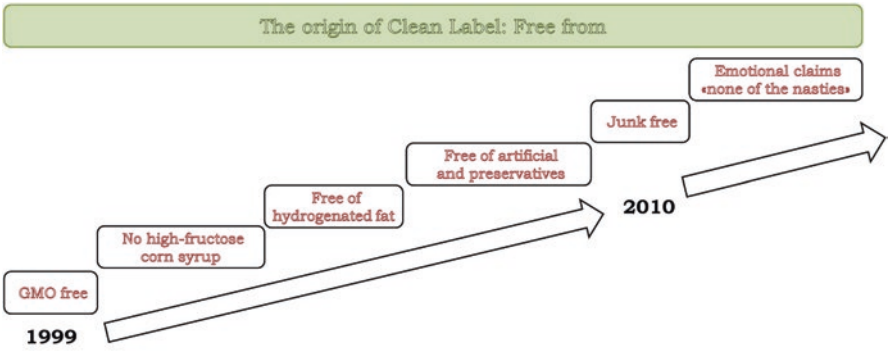

Fig. 1.2 Origin of "Clean Label"

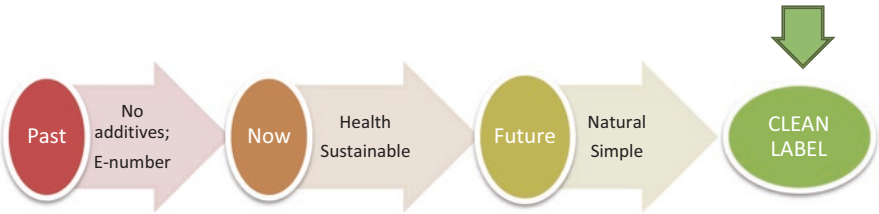

Fig. 1.3 Evolution of "Clean Label" Trend (Ingredion 2020)

1.1.1.1 Scientific Production

In Fig. 1.4, it can be observed the increase of scientific documents including Clean, Food and Label words (Scopus 2020). This means that in the last 10 years, the production per year increased more than 4-times.

Among countries, United States is by far the highest producer of documents including food "Clean Label" (Scopus 2020), producing at least three times more than the rest of the countries. Among European countries, Belgium and Ireland are the highest producers of documents related to "Clean Label" Foods.

What is more, "Clean Label" movement is a food manufacture's strategy, which also involves Food Agencies. Many of these Food Agencies work as funding sponsors for different scientific research, being Food Institutional Research Measurement the sponsor agency with the most scientific research done regarding "Clean Label" up to now (Scopus 2020).

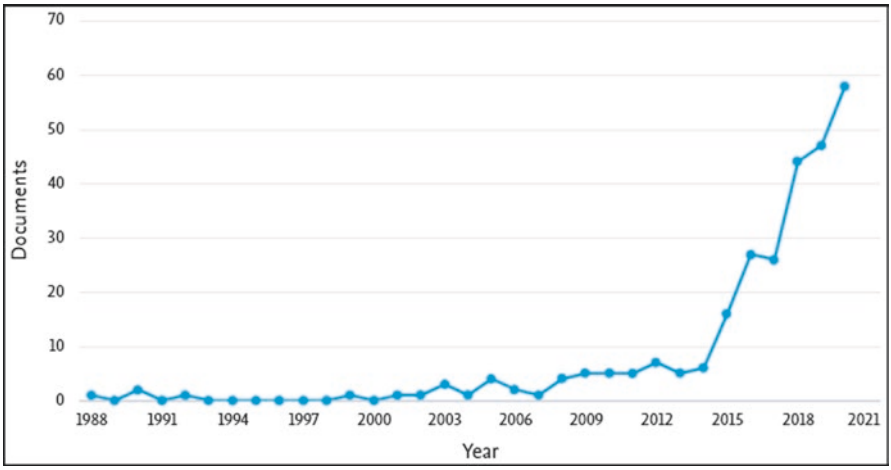

Fig. 1.4 Documents based on "Clean Label" Foods by year (Scopus 2020)

1.2 Food Labelling Regulations Worldwide

Nowadays, a wide variety of regulations, standards and guidelines on nutritional labelling exists around the world. Not only governments develop them, food industry is also involved. In some countries/regions, governments and food industry have not developed any policy or regulation; while in others, specific and well-written compulsory guides have been developed (FAO 2014).

1.2.1 Codex Alimentarius

The *Codex Alimentarius* (Food Code) is a set of standards, guidelines and codes of practice adopted by the *Codex Alimentarius* Commission (CAC). The CAC is the central part of the Joint FAO/WHO Food Standards Program and was established by FAO and WHO to protect consumer health and promote fair food trade practices. The kick-off meeting was held in 1963. The *Codex Alimentarius* contributes to the safety, quality and fairness of this international food trade. It is essential to indicate that its standards and texts are not mandatory. However, they are a truly international reference that although not compulsory is usually taken as reference in different countries (Food and Agriculture Organization off the United Nations, Organization WH 2017a). Due to the food products are following their specifications, consumers should trust the safety and quality. They need to be translated into national legislation or regulations to be enforceable.

1.2.1.1 Nutrition and Labelling

Thanks to the current technology applied in the food industry, it is possible to formulate novel food products according to consumers' expectations and preferences. Nowadays, consumer must face the defiance of labelling comprehension of what exactly they are buying and consuming, due to the diversity of options. Labelling data, about ingredients, nutrients, additives, etc. are essential for consumers by aiding them to decide when purchasing food products. In this regard, *Codex Alimentarius* offers a collection of standards and guidelines about the compositional requirements of food products to ensure that food products are nutritionally safe and can be traded. Moreover, *Codex* also provides support on general labelling about health or nutrient claims, using terms such as "fat free", "low fat", "high fat", "sugar free", etc.

The *Codex* Committee on Nutrition and Foods for Special Dietary uses (CCNFSDU) focuses on technical and regulatory topics for foods products to prevent nutritional deficiencies and diseases related to diet. On the other hand, the *Codex* Committee on Food Labelling (CCFL) provides standards and procedures regarding nutrition information on food packages to allow consumers to make informed food selections. The Nutrition and Food Labelling committees as well as industry and consumer associations leaders in member countries are key tools guiding the food system and achieving overall unanimity on nutrition topics (Food and Agriculture Organization off the United Nations, Organization WH 2017b).

1.2.1.2 Codex Documents on Food Labelling

As shown in Table 1.2, the Codex Alimentarius has made a great effort to clarify and provide recommendations on food labelling (WHO 2007) to aid companies, public authorities, and consumers in a better communication and understanding of the information provided to consumers. Standards, but also guidelines have been published.

1.2.2 EU Regulations on Food Labelling

Food regulations and policies assure safe food to consumers and accurate and honest information is also established. In the case of European Union, the specific law about labelling provides comprehensive information about food products' content and composition. Therefore, it can be stated that labelling helps consumers to make an informed decision about the foods they want to purchase (European Commission n.d.).

Table 1.2 Codex Documents on Food Labelling (Food and Agriculture Organization off the United Nations, Organization WH 2017c, d, e)

Reference		Title	Committee	Last modification
STANDARDS				
CXS 106-1983	*General Standard*	*"for Irradiated Foods"*	CCFH	2003
CXS 107-1981		*"for the Labelling of Food Additives"*	CCFA	2016
CXS 1-1985		*"for the Labelling of Prepackaged Foods"*	CCFL	2018
CXS 146-1985		*"for the Labelling of and Claims for Prepackaged Foods (Special Dietary Uses)"*	CCFL	2009
CXS 180-1991		*"for Labelling of and Claims for Foods (Special Medical Purposes)"*	CCNFSDU	1991
CXS 192-1995		*"for Food Additives"*	CCFA	2019
GUIDELINES				
CXG 1-1979		*"on Claims"*	CCFFP	2009
CXG 2-1985		*"on Nutrition Labelling"*	CCFL	2017
CXG 3-1989		*"for Simple Evaluation of Dietary Exposure to Food Additives"*	CCFA	2014
CXG 8-1991		*"on Formulated Complementary Foods for Older Infants and Young Children"*	CCNFSDU	2017
CXG 9-1987		*"General Principles for the Addition of Essential Nutrients to Foods"*	CCNFSDU	2015
GUIDELINES				
CXG 10-1979		*"Advisory Lists of Nutrient Compounds for Use in Foods for Special Dietary Uses intended for Infants and Young Children"*	CCNFSDU	2015
CXG 13-1991		*"for the Preservation of Raw Milk by Use of the Lactoperoxidase System"*	CCMMP	1991
CXG 23-1997		*"for Use of Nutrition and Health Claims"*	CCFL	2013
CXG 24-1997		*"for Use of the Term" "Halal"*	CCFL	1997
CXG 32-1999		*"for the Production, Processing, Labelling and Marketing of Organically Produced Foods"*	CCFL	2013
CXG 55-2005		*"for Vitamin and Mineral Food Supplements"*	CCNFSDU	2005
CXG 76-2011		*Compilation of Codex texts relevant to the labelling of foods derived from modern biotechnology*	CCFL	2011

(continued)

Table 1.2 (continued)

Reference		Title	Committee	Last modification
MISCELLANEOUS				
CXA 4-1989		*Classification of Foods and Animal Feeds*	CCPR	1993
CXA 6-2019		*List of Codex Specifications for Food Additives*	CCFA	2019

1.2.2.1 General Regulation

Some general labelling specifications should be considered (European Commission n.d.):

- The presentation of allergens such as gluten, lactose and nuts will be clear and harmonized in the ingredient list. It is recommended to focus on font and style of pre-packed foods.
- Allergen information is compulsory for non-prepacked food (including in restaurants and cafes)
- Legibility of the mandatory information must be present a minimum font size.
- The majority of processed food requires determined nutrition information.
- It is compulsory to indicate origin information for fresh meat (including ones from goats, poultry, pigs, and sheep.
- Both formed meat and fish one should be declared.
- Vegetal refined oil and fats must specify the origin.
- Labeling legislation must be complied as well as the form of sale (online, distance-selling or in a shop).
- List of engineered nanomaterials is included in the ingredient list.
- It is recommended to strengthen the current rules to prevent misleading practices.
- Indication of substitute ingredient for 'Imitation' foods.
- If the product is defrosted, it is necessary to declare this information.

1.2.2.1.1 Unfair Business-to-Consumer Commercial Practices

The information provided in food labelling should be clear and avoid misleading consumers. However, and due to marketing strategies, several terms are commonly included in food labels such as 'natural' 'simple' and others that are not specific, and not clearly defined. Food labelling information is included in official control schemes run by public authorities aiming to avoid consumers' misinformation and food fraud. Misleading actions with respect to food information are defined/clarified in Article 6 of D 2005/29/EC (EUR-Lex 2005):

> *A commercial practice shall be regarded as misleading if it contains false information and is therefore untruthful or in any way, including overall presentation, deceives or is likely to deceive the average consumer, even if the information is factually correct, in relation to one*

or more of the following elements, and in either case causes or is likely to cause to take a transactional decision that he would not have taken otherwise:

(a) the existence or nature of the product.

(b) the main characteristics of the product, such as its availability, benefits, risks, execution, composition, accessories, after sale customer assistance and complaint handling, method and date of manufacture or provision, delivery, fitness for purpose, usage, quantity, specification, geographical or commercial origin or the results to be expected from its use, or the results and material features of tests or checks carried out on the product.

The Commission staff working document guidance on the implementation/application of directive 2005/29/EC on unfair commercial practices detailed its application to specific sectors as following:

- Environmental claims
- The expressions environmental claims' and 'green claims' raise the fact that a good or a service has a positive or no negative impact on the environment or is less harmful to the environment than other goods or services. This can be achieved in all steps of food chain: manufacturing, product composition, acquisition, by reduction in energy or pollution expected from its use. On the contrary, if this claim is not effective or cannot be verified, this practice is called 'greenwashing'.
- 'Greenwashing' claim
- In this sense, the expression 'greenwashing' is refers to all forms of business-to-consumer commercial practices regarding the environmental characteristics of goods or services. This aspect can include all types of statements, information, symbols, logos, graphics, brand names, interaction with colors, packaging, labelling, and advertising (in mass and social media). Moreover, any organization can use it if it qualifies as a "trader" and joins commercial practices with respect to consumers.

1.2.2.1.2 Food Information to Consumers

The information included in this section is based on Regulation (EU) No 1169/2011 (EUR-Lex 2018a). The Regulation clarifies in the Article 1, 2, 9, 17, 18 and 20 the most relevant information about the topic involved, and it is the following:

- Article 1 stresses the fact that the Regulation provides the basis to protect consumers though food information, taking into consideration differences in consumer perceptions and information needs, while ensuring the functioning of the market.
- General principles, requirements and responsibilities regarding food information (including food labelling) are established in this Regulation. The rights of consumers to be informed and the procedures to provide food information are also stated. Procedures take into consideration future developments and needs regarding food information.

- Article 2
- This article defines the terms 'label' and 'labelling' *"'label' means any tag, brand, mark, pictorial or other descriptive matter, written, printed, stencilled, marked, embossed or impressed on, or attached to the packaging or container of food"*.

  'Labelling' means any words, particulars, trademarks, brand name, pictorial matter or symbol relating to a food and placed on any packaging, document, notice, label, ring or collar accompanying or referring to such food.

- Article 7 states that the information provided shall be accurate, not be misleading and should be clear and easy to understand by consumers.
- Article 9 states that food product name and the list of ingredients, should be included in the label.
- Article 17 clarifies which should be the name of the food: the legal name, and in case of no legal name the customary name has to be used. If there is no customary name, a descriptive name of the food has to be provided
- Article 18 provides instructions regarding the list of ingredients. A clear heading, such as the word 'ingredients' should precede the list, and ingredients should be listed in descending order of weight used in the formulation at the time of use.
- Article 20 details those constituents that do not need to be included in the ingredients' list:

  (a) those constituents of a food ingredient, that had been temporarily separated during processing and that are later on reintroduced without exceeding their original proportion*;* dairy fat separated and further reintroduced for milk standardization would be an example of this exception.

  (b) those additives and enzymes*: "(i) whose presence in a given food is solely due to the fact that they were contained in one or more ingredients of that food, in accordance with the carry-over principle referred to in points (a) and (b) of Article 18(1) of Regulation (EC) No 1333/2008, provided that they serve no technological function in the finished product; or (ii) which are used as processing aids;"*

  (c) "carriers and substances which are not food additives but are used in the same way and with the same purpose as carriers, and which are used in the quantities strictly necessary";

  (d) "substances which are not food additives but are used in the same way and with the same purpose as processing aids and are still present in the finished product, even if in an altered form";

  (e) water used only for reconstituting concentrated or dehydrated ingredients; or used in liquid mediums not normally consumed.

- Article 21 states that it is compulsory that a clear and highlighted reference to certain substances or products causing allergies or intolerances has to be included in food labels. Such compounds should be included in the list of ingredients. Making a clear reference to the name of the product (nuts, celery…) or substance (lactose, gluten…). Such products and compounds are included in Annex II and have to be clearly highlighted to be distinguished from other ingredients by means of a higher font size, style or color.

1.2.2.1.3 Nutrition and Health Claims Made on Foods

Food claims help consumers to associate a product with nutritional, physiological, or other health advantages over similar or different products to which such nutrients and other substances are not added. In this way, consumers are aware of their total intake of individual nutrients or other substances. Consequently, it is compulsory to require restrictions for those products holding claims to avoid potential undesirable effect. In this context, aspects such as the presence of specific substances, or the nutrient profile of a product, are suitable standards for determining whether the product can hold a claim or not.

The Regulation (EC) No 1924/2006 includes information about nutrition and health claims made on foods (EUR-Lex 2014a). The most relevant definitions included in the Article 2 of the above-mentioned Regulation are shown:

- 'Claim'

  Any message or representation, which is not mandatory under Community or national legislation, including pictorial, graphic or symbolic representation, in any form, which states, suggests or implies that a food has particular characteristics.

- 'Nutrition claim'

  Any claim which states, suggests or implies that a food has particular beneficial nutritional properties due to: (a) the energy (calorific value) it (i) provides; (ii) provides at a reduced or increased rate; or (iii) does not provide; and/or (b) the nutrients or other substances it (i) contains; (ii) contains in reduced or increased proportions; or (iii) does not contain.

- 'Health claim'

  Any claim that states, suggests or implies that a relationship exists between a food category, a food or one of its constituents and health.

- 'Reduction of disease risk claim'

  Any health claim that states, suggests or implies that the consumption of a food category, a food or one of its constituents significantly reduces a risk factor in the development of a human disease.

Additionally, some key principles for all claims are included in the Article 3. *"The use of nutrition and health claims shall not:*

i. *be false, ambiguous or misleading;*
ii. *give rise to doubt about the safety and/or the nutritional adequacy of other foods;*
iii. *encourage or condone excess consumption of a food;*
iv. *state, suggest or imply that a balanced and varied diet cannot provide appropriate quantities of nutrients in general;*
v. *refer to changes in bodily functions which could give rise to or exploit fear in the consumer, either textually or through pictorial, graphic or symbolic representations".*

Table 1.3 shows a community list of permitted claims included in the Article 13 (European Commission 2016).

Table 1.3 Authorized nutrition claims (European Commission 2016)

AUTHORIZED CLAIMS ABOUT THE AMOUNT OF ENERGY
Low energy value, reduced energy value, no energy intake, light, reduced energy content.
AUTHORIZED CLAIMS ON THE PRESENCE OF SUGARS
Low sugar content, sugars free, no added sugars, reduced sugar content.
AUTHORIZED CLAIMS ON THE PRESENCE OF FATS
Low fat content, fat free, low in saturated fat, no saturated fat, reduced content of fat or saturated fat, source of omega-3 fatty acids, high content of omega-3 fatty acids, high content in monounsaturated fats, high content of polyunsaturated fats, high unsaturated fat content.
AUTHORIZED CLAIMS ON THE PRESENCE OF SALT
Low sodium/salt content, very low sodium/salt content, no sodium or no salt, reduced salt content.
AUTHORIZED CLAIMS ON THE PRESENCE OF FIBER
Fiber source, high fiber content.
AUTHORIZED CLAIMS ON THE PRESENCE OF PROTEINS
Protein source, high protein content.
AUTHORIZED CLAIMS ABOUT THE PRESENCE OF VITAMINS AND MINERALS
Source of [name of vitamins] or [name of minerals], high in [name of vitamins] or [name of minerals], reduced content of [micronutrient name], higher content of [nutrient name].

What is more, given the high number of applications for the authorization of food claims, the European Commission, aiming to clarify and aid in this process, published a list of authorized health claims, other than those referring to the reduction of disease risk and to children's development and health in Regulation (EU) No 432/2012 (EUR-Lex 2012a). Article 13 of the Regulation includes a long list of approved health claims, which may be made on foods. The Annex included in this Regulation contains a LIST OF PERMITTED HEALTH CLAIMS. The list includes "nutrient, substance, food or food category. Claim. Conditions of use of the claim. Conditions and/or restrictions of use of the food and/or additional statement or warning. EFSA Journal number. Relevant entry number in the Consolidated List submitted to EFSA for its assessment".

1.2.2.2 Regulation Related to Terms Included in "Clean Label"

In recent years, the trends, and patterns of consumption in society have undergone an important evolution, incorporating new variables in purchase decision making, such as long-term health, environmental sustainability, animal welfare or ethical values in food production. This phenomenon has been magnified and accelerated by the explosion of social media platforms as a source of information for the consumer. Moreover, several influencers (own and outside the food sector) have started and promoted trends with an important impact on consumer perception about certain attributes or product characteristics (sometimes without supporting evidence) (AECOC n.d.).

The regulatory framework on the use of these attributes, either directly or generally, it is broad, complex and, in some cases, diffuse, encompassing all types of legislation (European, Spanish or Autonomic Region), private regulations, decisions or official positions, among others.

1.2.2.2.1 Trends in Agri-Food Production

Ecological, BIO, Organic

The concept of 'natural' is commonly linked to 'organic', being the first one a non-defined term and the second regulated by law. Organic production in growing worldwide as well as the demand for organic foods, which are among the best candidate foods for "Clean Label" use. Ecological, Bio and Organic concepts are included in the Regulation (EU) 2018/848 and Regulation (EU) 834/2007 (EUR-Lex 2018b). European Regulations on organic production lay down principles and rules of organic production, certification, and use of indications, labelling and advertising. Rules regarding official controls affecting organic production and labelling are included in Regulation (EU) 2017/625 (Article 1i) (EUR-Lex 2017).

The Regulation clarifies in the Article 5 the general obligations concerning the competent authorities and the organic control authorities, focusing mainly on organic production as a sustainable management system based on:

(a) respect for nature's systems and cycles and the sustainment and enhancement of the state of the soil, the water and the air, of the health of plants and animals, and of the balance between them;

(b) the preservation of natural landscape elements, such as natural heritage sites;

(c) the responsible use of energy and natural resources, such as water, soil, organic matter and air;

(d) the production of a wide variety of high-quality food and other agricultural and aquaculture products that respond to consumers' demand for goods that are produced by the use of processes that do not harm the environment, human health, plant health or animal health and welfare;

(e) ensuring the integrity of organic production at all stages of the production, preparation and distribution of food and feed;

(f) the appropriate design and management of biological processes, based on ecological systems and using natural resources which are internal to the management system, using methods that: (i) use living organisms and mechanical production methods; (ii) practice soil-related crop cultivation and land-related livestock production, or practice aquaculture which complies with the principle of the sustainable exploitation of aquatic resources; (iii) exclude the use of GMOs, products produced from GMOs, and products produced by GMOs, other than veterinary medicinal products; (iv) are based on risk assessment and the use of precautionary measures and preventive measures, where appropriate;

(g) the restriction of the use of external inputs; where external inputs are required or the appropriate management practices and methods referred to in point (f) do not exist, the external inputs shall be limited to: (i) inputs from organic production; in the case of plant reproductive material, priority shall be given to varieties selected for their ability to meet the specific needs and objectives of organic agriculture; (ii) natural or naturally-derived substances; (iii) low solubility mineral fertilizers;

(h) the adaptation of the production process, where necessary and within the framework of this Regulation, to take account of the sanitary status, regional differences in the ecological balance, climatic and local conditions, stages of development and specific husbandry practices; (i) the exclusion from the whole organic food chain of animal cloning, of rearing artificially induced polyploid animals and of ionising radiation;

(j) the observance of a high level of animal welfare respecting species-specific needs".

It is important to highlight that the term Ecological can be substituted in the labelling for Biological, Eco, Bio or Organic. These products are generally perceived as healthier, safer or of higher quality than conventional products, although, at present there is no scientific evidence to support such claims (positioning of the European Food Safety Authority) (Kneafsey et al. 2013). Main traits of organic production are environmental, biodiversity and animal welfare protection as seen in the listed articles.

Sustainable

There is no specific regulation of this attribute, so there is no legal definition of this word. It is understood that a sustainable product is one that has been generated in accordance with the environment and is different in each country, even within the same food category (Sánchez-Bravo et al. 2020, 2021). The concept of sustainability has many approaches and nuances that are interconnected. In this sense, its definition should be regulated and its intrinsic characteristics clarified. This implies for sustainable products: Acceptable ecological footprint, fair social conditions, reduced packaging, absence or minimal presence of additives and basic ingredient lists. In the present chapter, the focus is given only to those technical aspects of sustainability that may be measured and certified. There are different certificates related to sustainability, both generic and by sector or activity. For example: ISO 14000 (environmental management), ISO 26000 (social responsibility), UNE 15500 (management system for the production of fruits and vegetables respectful with the environment), MSC (sustainable fishing), etc.

It needs to be pointed out that 'sustainable', as well as 'natural' are widely used terms, which use needs an in deep critical analysis in search of clear definitions to avoid misunderstandings and contradictions. They are not always compatible, as an example: sustainability and natural concepts are sometimes contradictory. Some practices, such as the extraction of small quantities of natural flavors, sweeteners, or phytonutrient involving the use of considerable amounts of resources to grow plants (land, water, energy) may be natural but not sustainable. Could it be by far "more sustainable" to produce the key substances via fermentation processes (using yeasts or other microorganisms engineered) thousand times more efficient?. A careful and more specific use of those terms would be capital to clarify the message to consumers.

Biodynamic

There is no specific regulation of this attribute, so there is no legal definition of the attribute. Biodynamic agriculture is a method of agriculture considered ecological, based on Rudolf Steiner's theories, founder of anthroposophy. Certification of products and obtaining the registered trademark "Biodynamic Product" depend on the private group Demeter.

In Europe, to obtain biodynamic certification, the farm must be previously certified in organic farming under European Regulations. Biodynamic production is not based on commonly accepted scientific evidence.

Seasonal

Eating seasonal and local food is a message sent by non-governmental organizations, mainly promoted in social media to reduce the environmental impact by shifting current dietary intakes unto more sustainable diets (Macdiarmid 2014).

There is no specific regulation of this attribute, so there is no legal definition of the attribute. The scientific literature proposed 2 definitions for seasonal food, one related with the place where the product is produced and the other based on the place the product is produced and consumed (DEFRA 2012):

- "*Produced in season (Global): Food that is outdoor grown or produced during the natural growing/production period for the country or region where it is produced. It need not necessarily be consumed locally to where it is grown.*
- *Food that is produced and consumed in the same climatic zone without high-energy use for climate modification or storage*".

Consequently, they are fresh products, usually agricultural and fisheries that, naturally and due to their biological cycle, are at the optimum moment of production at some time in the country or region of consumption (respecting the seasonality of the productions).

1.2.2.2.2 Trends in Environmental/Social Responsibilities

Local, Proximity, km 0

There is no specific regulation of this attribute, no legal definition of the attribute. It refers to products that are produced and processed within a relatively short distance between producer and consumer, near or nearby. Most groups and administrations assume that proximity products or km 0 do not exceed the 100 km radius between production and sale.

The intrinsic characteristics of this type of products are:

- Cooler and with a longer shelf life not elapsed at the time of purchase.
- Greater consumer confidence due to proximity to its origin.
- Consumption models that reduce polluting emissions (by transport).