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Aware Food Choices: Bridging the Gap Between Consumer Knowledge About Nutritional Requirements and Nutritional Information

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Contents

Chapter 1
Introduction

In recent years, evolution in many disciplines, directly or indirectly related to the subject of nutrition, has led to unprecedented developments in research which in turn have led to the production of new foods with a high nutritional level. Increasingly complex and elaborate foods have appeared on our table accompanied by advertising slogans extolling their healthy virtues. Consumers have been quick to respond, ever more aware of the need to maintain a state of well-being and health in keeping up with globalized aesthetic standards. Some researchers have highlighted how choices based on the nutritional indications, which accompany the sale of food products, do not always meet the real needs of the individual (Pollan 2008). A sample of American students involved in a research project were asked to identify the most important food item capable of guaranteeing survival for a year on a desert island where the only substance offered by nature was water. The foods they could choose from included alfalfa sprouts, hot dogs, spinach, peaches, bananas, milk chocolate and corn. The result was surprising in that 42 % of the interviewees put bananas in first place, 27 % chose spinach whilst essential nutritional foods—capable of providing energy, carbohydrates and proteins—such as hot dogs (4 %), milk chocolate (3 %) ended up at the bottom (Rozin et al. 1996, p. 442). In his book In Defense of Food, Michael Pollan, quoting research by Rozin et al. (1996), points out how the 'outlawing' of certain foods because of an excessive fat content or because they are commonly considered responsible for bad eating habits prevents the consumer from choosing objectively as he falls prey to widespread advertising slogans he has over time gradually interiorized. For the past five years, I have asked my students the same question at the beginning of my Food Sciences course and surprisingly I get very similar answers with a clear preference for bananas, and alfalfa sprouts with hot dogs and chocolate relegated to the last places. This shows that in the collective consciousness, some foods are considered bad for one's health and not useful for survival. Of course, man is the result of the long evolutionary process which has taken place in the relationship between available food, environment and genetic make-up; consequently, studies on nutrition prove to be highly complex and multidisciplinary. In fact, research is necessary on food availability (for example, in the fields of agronomy

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and veterinary medicine), on the external environment (in the fields of economics, ecology, statistics, social and demographic studies) and on genetic make-up (in the fields of biology, chemistry and medicine). Consequently, the food choices a lot of people make on impulse and condition by a myriad of factors (family, the media, lifestyle, a desire to emulate, the quest for well-being and a certain image) are not always aligned with the real needs of the individual who should consider a complex and far more articulated system of factors than can be imagined.

In Chaps. 2, 3 and 4 of the present volume, we attempt to describe the fundamental notions underlying the concepts of food and nutrition in the light of the systemic relations which link these two disciplines and to provide useful food for thought. In fact, eating is a mathematical equation: if daily intake exceeds an individual's daily requirement, he will gradually increase in weight and vice versa in the case of a gradual reduction in energy intake. Obviously the aim of a correct diet is to provide all the substances necessary for the metabolism to function, while maintaining an ideal body weight. It is well-known that an unbalanced and incomplete diet which is either too rich or too poor is considered responsible for the insurgence of many pathologies (FAO, IFAD and WFP 2015). In industrialized countries, for example, the most common are diabetes and cardiovascular disease linked to a gradual increase in food consumption and to the growing problem of obesity. In Europe for example, the kilocalories available daily per capita have increased from 3,255 in 1970 to 3,359 in 2010 representing an increase of just over 3 %. To be more specific, the protein resources available—measured in grams per head per day—have increased by 6 % whilst the fats available have increased as much as 23 %. The situation in America reveals even more worrying data: there has been an approximate increase of 20 % in available energy from 1970 to 2010, the increase in protein resources is about 13 % whereas for fats it is almost 34 % (FAO 2013). In Europe, it maybe the gradual change in the type of food consumed, increasingly oriented towards global models compared with the past, rather than the quantity of food which presents a greater cause for concern.

From Chaps. 5–7, we describe the role of the different types of nutrition label in informing the consumer and assessing product quality. In particular, we are going to examine and highlight the main characteristics, differences and informational limitations of European and North American methods of labeling. Finally, in the light of recent developments suggested in the literature, we analyze new proposals for food labeling which aims to make the understanding of product quality simpler and more immediate.

The authors, while aware of the shortcomings of this analysis and of the need for further study and developments in sister disciplines hope that an awareness of the issues raised will, on the one hand, put the consumer in a position to make more rational choices, less conditioned by innovative slogans from the food industry (*rem tibi quam scieri saptam dimittere noli*, Catone, Distici, 2,26) and, on the other, encourage the industry to provide better information for the consumer, who has always been the weak link in the food chain.

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Chapter 2
Literature Analysis on Consumer Understanding of Nutrition Information

Abstract With the continuous introduction of new products claiming nutrition and health benefits, the development of food market reveals some issues with regards to consumer understanding and perception of these actual messages. In general, many questions arise regarding the effective comprehension of nutrition information—made by consumers on food and in promotion—and about the actual use of such information in food choices and purchasing decisions, in order to support a healthy diet concept. Indeed, it seems that many consumers have difficulty in understanding nutritional information and prefer simpler ways in providing such information, which is able to help them in the rapid evaluation of nutritional characteristics of a foodstuff. In addition, specific consumer features and conditions influence their preferences and perception of foods with health-related benefits. In the present chapter, results are presented from a literature review on factors influencing consumer perception, understanding and use of nutrition information made on food. Finally, some results achieved by the selected papers are analyzed, and implications discussed.

Background: Consumer Food Choices and Nutrition Information

The social and economic welfare and the large availability of foods on the market have increased consumption and daily caloric intake (FAO 2013). Nutrition and medical science have tried to steer consumers towards food choices by meeting health and well-being demands. The demand for food products that promote health and nutrition benefits has really boosted (Leatherhead Food Research 2014) during the last few years, thereby encouraging the food industry to innovate and develop new products with improved nutritional properties. Food health benefits are among the most important innovation drivers of the global food and drink market, also due to an increasing ageing population in richer countries (Robinson 2014). Foods with health-related benefits are generally called functional foods.

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The latter has several definitions which vary from simple "foods that may provide health benefits beyond basic nutrition", to complex "food similar in appearance to conventional food, that is intended to be consumed as part of a normal diet, but has been modified to subserve physiological roles beyond the provision of simple nutrient requirements" (Roberfroid 2000, p. 13). In any case, healthy properties of foods have to be communicated because they are typically credence attributes that must be conveyed to consumers through information (Darby and Karni 1973), and their best carriers are labels, as well as claims made on the package and in promotion. During the last few years, several nutrition information formats and many terms expressing health-related benefits have appeared on food packages in order to support consumer choices (Carrillo et al. 2012). Given the increasing amount of several differentiated formats continuously appearing on the market, worldwide legislators have tried to rule nutrition information made on food packages in order to protect consumers and their preferences from misleading messages. However, today some concerns still exist about the actual contribution of this information, to help consumers in a healthier food consumption. These issues have mostly a dual origin: the existing differences between worldwide regulations regarding information on food; and the actual impact of nutrition information on consumer food preferences for a healthier diet, namely, if consumers use nutrition information in their food decision-making and food choices. However, the recent modifications in regulations and the new or subsequent introduction of mandatory nutrition labelling in many countries, European Union included, seem to trace a converging trend, which can help overcome the former detected obstacle (EUFIC 2015). The impact that nutrition information has on food preferences can relate to the consumer competence regarding the understanding of nutrition information on food. To this regard, the numerous studies and analysis that have been conducted with time, reveal mixed results (Lähteenmäki et al. 2010). The first results of a research carried out by the authors seem to highlight that consumers have a general knowledge of correct nutrition, but they scarcely use their knowledge in food decision-making and purchasing. Annunziata and Vecchio (2012) have also reported that consumers do not use nutrition information made in foods packages, and in particular, on food labels, because it is not easy to understand. Consumer knowledge on nutrition information and its use in food choices seems to be largely influenced by subjective features and personal conditions such as age, interest in healthy habits and social status (Grunert et al. 2010). It should also be noted that purchasing impulses may be originated by both internal personal convictions, and external signals (Shepherd 1989). In fact, food preferences are influenced by sensory and non-sensory factors, which concur to shape consumer perception (Ares et al. 2010). Therefore, worldwide legislators shall take into consideration all aspects influencing consumer perception regarding nutrition messages, in order to define a globally harmonized nutrition information format that is really able to create an impact on consumer food preferences. Such a label could really be used as the preferred driver of the decision-making process in healthier food choices. This chapter aims at contributing to provide information regarding consumer understanding of nutrition information, and factors affecting the related knowledge and use through an extensive literature review of the empirical analyses published. Findings may help the food industry enhance nutrition labelling, and governments to create a coherent and unique framework for the mandatory use of nutrition information, so as to help consumers.

Methods of Literature Review

The literature review has been developed using a rigorous protocol selection for papers, which has consisted in searching for keywords from the databases. In particular, computer research has taken the Web of Science (hereinafter WoS) into consideration, Scopus and European Business Source Complete (hereinafter EBSCO). Keywords have been chosen in order to obtain a large panel of papers. Only one set of primary strings has been applied to databases, without refining the first stage of computer research with secondary keywords. In particular, the exact phrase "consumer* understanding" has been searched for in abstracts by using the Boolean operator OR with the exact phrase "consumer* comprehension" and the operators AND and OR, respectively, with the words "food" and "nutrition". Relevance of papers returned from EBSCO has been assured by limiting results to papers published in Academic Journals. No filter regarding the date of publication has been applied. The selection protocol has returned 377 abstracts: 105 have been deleted because they are replications, and 272 have been manually sorted by relevance to the paper objectives. In this way, more than 130 papers (132) have been detected in order to be analyzed. The discarded 142 papers did not meet the objectives of the research, i.e. they do not deal with consumer comprehension of labels made on foods packages, or in food promotion. The remaining papers were first sorted according to the type of label treated, and the results of these classifications are shown in Fig. 2.1. Given that some papers (5 %) have investigated the level of consumer understanding of nutrition information suggested by nutrition guides, the latter have been considered as nutritional information labels, in order to make classification easier.

The cluster called *nutritional information* includes all papers dealing with research, and studies on all existing formats of nutritional information made on food packages, such as nutrition labelling—namely the US facts panel or the EU nutrition declaration—and daily energy requirements, nutrition and health claims, traffic lights and other different forms of FoPs. In addition, *sustainable food* refers to all products labelled with ethical, environmental or quality certification, as well as with traceability of country of origin indications, or produced with more sustainable practices. For both clusters, a detailed list of the considered labels is reported close to the relative graphic sector.

As shown in Fig. 2.2, computer search has returned papers published starting from 1978. With time, there has been an increasing attention to consumer understanding or perception of food labels by scientific literature, and in the last few years, this attention has been specifically focused on labels containing nutrition

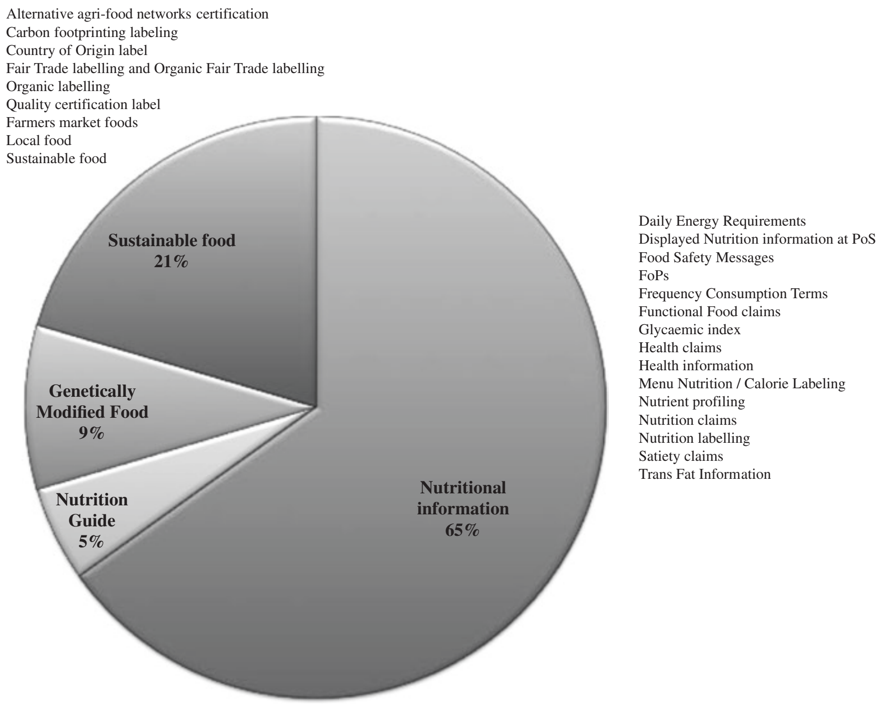

Fig. 2.1 Food labels treated in the analyzed papers

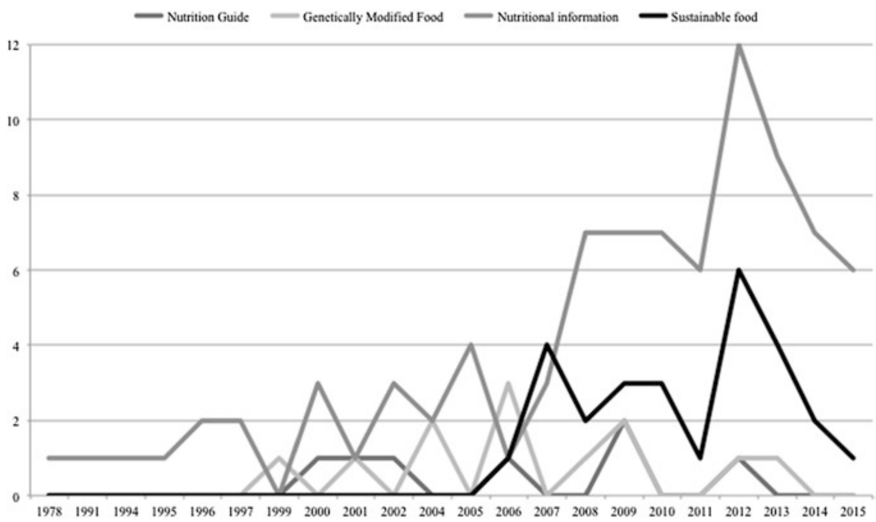

Fig. 2.2 The time distribution of the analyzed papers

information, or suggesting product sustainability. However, within the scope of the present work, only papers showing the assessment of consumer comprehension of nutrition information and nutrition guides have been analyzed in depth in the content. Specifically, the text analysis of the resulting 93 papers took objectives, results and the country of investigation into consideration. Objectives of these articles are mostly classified in *Understanding and use of nutritional information*, including factors influencing them, and in *Nutritional information policy /regulation effectiveness*. In particular, the first cluster also includes papers analyzing the general attitude of consumers towards foodstuffs showing nutritional information labels or representations, and how these formats affect consumer preferences and purchasing behavior. The level of consumer understanding on nutrition information and the relation with the use of such information to promote awareness in food choices were extracted from results of the selected papers, as well as features—personal, objective, or contextual—influencing such a level, and consumer perception.

Results on Consumer Understanding of Nutrition Information

About 18 % of the resulting 93 papers focus on evaluating the effective-ness of current policies or systems in providing nutritional information to consumers. In particular, these papers specifically deal with health claims (Nocella and Kennedy 2012; O'Connor 2011; Richardson 2012, 2014; Jun and Yeo 2008), general nutrition labelling (Best and McCullough 1978; Hurt 2002; Moss 2006), nutrient profiling (Bryans 2009; Nafziger 2008; Scarborough et al. 2007), functional food claims (Hirahara 2005; Taylor 2004), food and nutrition guide (Pijls et al. 2009; Shaw et al. 2000), Glycemic index (Slabber 2005), and both nutrition and health claims (Aschemann-Witzel 2011). In addition, two of them also propose new formats for nutrient profiling and food guide respectively, in order to facilitate consumers in a healthier consumption of food (Scarborough et al. 2007; Shaw et al. 2000). These 17 papers show interesting and more effective cues for the policy and regulation review, in order to define nutritional information systems in protecting consumers, while promoting market differentiation and innovation in food industry. However, they do not provide useful insight on the level of consumer understanding of nutrition information made on food, and relative use for food choices. Such evidence is shown by most papers included in the specific cluster called *Understanding and use of nutritional information.* As reported in Fig. 2.3, more than 90 % of these papers have investigated the level of consumer understanding on nutritional information made on food package, while only 6 % have carried out a similar research by taking nutrition indications suggested by food or nutrition guides into consideration. With regard to the latter, they prove that there is a general understanding of nutrition key concepts provided by the food pyramid, but specific knowledge of correct food group placement and appropriate serving size is very poor (Britten et al. 2006;

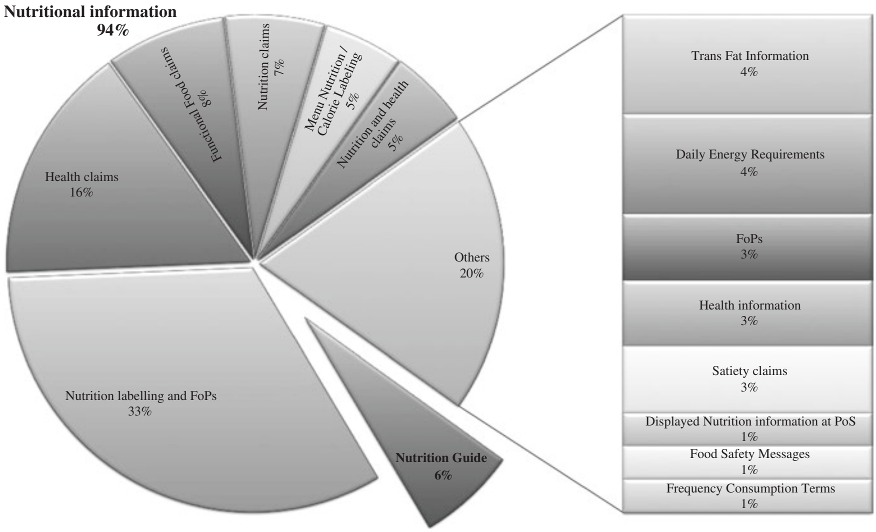

Fig. 2.3 Food labels treated by papers classified under the cluster Understanding and use of nutritional information

Tuttle 2001). In addition, Keenan et al. (2002) found that consumers have difficulty interpreting Dietary Guidelines, and in particular, fat. Figure 2.3 shows that most papers focusing on the analysis of consumer understanding of nutrition information made on food have investigated the comprehension of different formats in nutrition labelling and FoPs, as well as several nutrition and health claims. The analysis of these papers revealed that consumer ability in correctly extracting and using nutrition information from nutrition labelling is quite scarce (Fatimah et al. 2010; Jones and Richardson 2007; Liu et al. 2015b).

Though consumers tend to perceive nutrition labelling and FoPs as a reliable source of nutrition information, and the self-reported used of these labels is high (Campos et al. 2011; Cowburn and Stockley 2005; Guthrie and Saltos 1995), more objective analyses show that consumers rarely use nutrition labels in their food choices (Cowburn and Stockley 2005; Guthrie and Saltos 1995; Liu et al. 2015b; Mhurchu and Gorton 2007; Tessier et al. 2000). Indeed, the most important barriers to using nutrition labels are firstly, the general lack of understanding, knowledge and confidence with nutrition information terms, symbols, and values (Besler et al. 2012; Jacobs et al. 2011; Liu et al. 2015b) and secondly, the format of presentation (Baltas 2001; Besler et al. 2012) because consumers complain about the font size being too small (Jacobs et al. 2011; Tessier et al. 2000). Indeed, consumers demand a simplified standard with clearer and more comprehensible indications (Besler et al. 2012). Consumer understanding of labels was also affected by the presence of FoPs (Ares et al. 2012), which is evaluated positively if in graphical format (Geiger et al. 1991), such as the traffic light for instance (Roberto et al. 2012). Smith Edge et al. (2014) have shown that FoP labels with complete

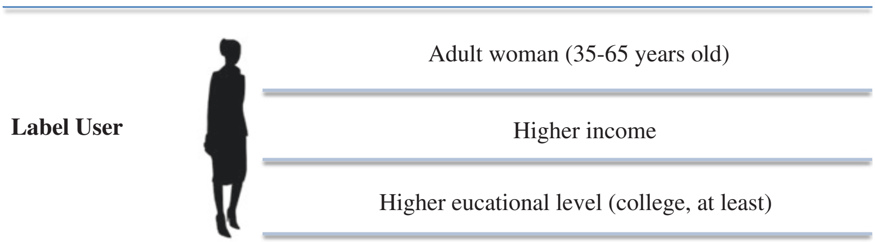

Fig. 2.4 The profile of the average Label User. Source: Our elaboration of Guthrie and Saltos (1995), and Josiam and Foster (2009)

information improve consumer comprehension of nutrient content in foodstuffs. However, the existence of multiple FoP formats limits consumer comprehension and discourages their use (Draper et al. 2013). In addition to the level of consumer knowledge of nutritional information, the use of nutritional labelling and FoPs also depends on several subjective, objective and contextual characteristics. The former includes consumer socio-demographic conditions (Burton and Andrews 1996; Worsley 1996), sex, age, marital status, level of education (Besler et al. 2012), and perceived product attributes such as taste (Jacobs et al. 2011) (Fig. 2.4). Objective factors are mainly price (Jacobs et al. 2011), wording, and other product features (Annunziata et al. 2014), while contextual characteristics refer to situational time constraints (Jacobs et al. 2011). In most cases, major attention to health or nutritional information and being on the lookout for nutrition labels by consumers, seem to be related to a general food involvement (Hansen et al. 2013), and a voluntary healthier diet (Campos et al. 2011; Guthrie and Saltos 1995) or a low fat/low cholesterol diet, following medical advice (Guthrie and Saltos 1995).

With regard to nutrition and health (hereinafter NH) claims, understanding and perception, it was found that consumers hardly distinguish between these two different kinds of labels (Verhagen et al. 2010). In this regard, concerning health and nutrition claims, it is noted that the veracity of the claim plays an important role. If nutrition labelling and information confirm the claim message, it is likely that consumer expectations are satisfied (Mazis and Raymond 1997). Conversely, consumers will probably develop a negative opinion about products with claims that are not validated by nutrition information. Besides, by generating expectations about health benefits, nutrition and health claims could influence the hedonic appreciation, and lastly, sensory factors (Varela et al. 2010). The contemporary analysis of nutrition information or labelling, and NH claims, seems to decrease the efficacy of the latter in supporting consumer food choices (Andrews et al. 2000; Ford et al. 1996; Garretson and Burton 2000). In such cases, information about nutrition properties seems to prevail on claims, diminishing confidence toward the latter if they are biased by the former, as discussed above. Carrillo et al. (2012) have also highlighted that although NH claims—as non-sensory features—effectively influence the first acquisition, only sensory characteristics determine loyalty and repeat consumption. Moreover, NH claims probably do not influence food choices, because they don't seem to drive product evaluations or purchase intentions (Naylor et al. 2009; Wills et al. 2012), and they can decrease the perceived naturalness (Lähteenmäki et al. 2010). Although consumer perception of nutrition and health claims is quite positive (Ares et al. 2010; Burton et al. 2000; Carrillo et al. 2012; Kozup et al. 2003; Wansik and Chandon 2006), it is affected by both personal and objective factors, as shown for nutrition labelling. In particular, perceived relevance of health characteristics and attitudes towards food health properties or functional foods are important drivers of consumer perception (Andrews et al. 1998; Dean et al. 2012; Lähteenmäki 2013), as well as consumer product involvement (Aschemann-Witzel and Hamm 2010; Hansen et al. 2013) while socio-demographic conditions have a minor impact (Lähteenmäki 2013). With regard to more objective drivers, country differences in food habits can affect NH claims (Bech-Larsen and Grunert 2003; Dean et al. 2007; Van Trijp and Van der Lans 2007). In addition, other studies have pointed out that perception of NH claims is related to the carrier product, namely it is linked to its general healthy image (Lähteenmäki 2013; Wills et al. 2012), or specific type of claims (Van Trijp and Van der Lans 2007), or contained functional ingredients (Bech-Larsen and Grunert 2003; Dean et al. 2012; Rimal 2005; Urala and Lahteenmaki 2003; Wills et al. 2012), while wording is mostly case sensitive (Annunziata et al. 2014; Lähteenmäki 2013; Williams 2005). In relation to the different levels of scientific substantiation required in some countries for the approval of health claims, consumers have difficulty in discriminating among these levels, and it is hard to understand if they perceive the variations in scientific support correctly (Hooker and Teratanavat 2008; Kapsak et al. 2008; Kim et al. 2010). Lastly, similarly to that found for nutrition labelling and FoPs, consumers showing familiarity with functional foods of the claimed nutrition or health effects are more favorable towards these products (Lähteenmäki 2013; Williams 2005). Menu nutrition or calorie labelling do not impact on restaurant choice (Jun et al. 2009), though some market segments for eating healthy food at home are more likely to use this information in restaurants (Josiam and Foster 2009). In general, consumers are not able to understand levels of calorie and nutrition fundamentals of restaurants correctly—quick service (Burton et al. 2009)—meals, and to this purpose, there is evidence that the introduction of calorie ranges really reduce energy misestimation among different menus (Liu et al. 2015a). To conclude the present review concerning the results obtained by previous research on consumer understanding of nutritional information, displays at Point of Sales (PoS) seem to improve knowledge, but they fail to increase retention (Colapinto and Malaviarachchi 2009). Suggestions from this literature analysis mainly highlight the need to improve consumer nutritional knowledge (Burke et al. 1997; Kozup et al. 2006; Jacobs et al. 2011), although this does not necessarily result in a positive impact on consumer purchasing decisions to buy healthier food (Williams 2005). Indeed, as obtained by Onozaka et al. (2014), consumer intentions to buy foodstuffs claiming nutritional or health benefits is not directly related to knowledge or interest in healthy eating, but other behavioral factors.

Conclusion

Previous studies have highlighted that consumers have a general knowledge on nutrition key concepts, but they are poorly able to place food groups correctly, and to define the appropriate serving size with respect to the suggested optimal nutritional needs. This fact may negatively impact the awareness of existing links between food and nutrition components and diet, explaining why consumers rarely use nutritional information made on foods, though they perceive nutrition labelling and FoPs as reliable sources of nutrition information. Moreover, numerous items like socio-demographic and cultural features, product involvement and perceived relevance, as well as product category, affect consumer ability to use nutrition labelling and FoPs for their food choices correctly. These results indicate the need of more research on what kind of information or knowledge regarding nutrition, food principles and components, and related health effects, have to be provided to consumers, and in which way, in order to really help them gain awareness in composing a healthy diet. Evidence from such new studies could support experts and policy makers in planning new solutions—labels, educational pathways, displays at shops—for communicating nutritional information and increasing consumer comprehension concerning links between health and diet. Consumers could really be made more aware of food choices, resulting in more balanced consumption habits. In this way, the food industry and market could also benefit because they could continue to innovate and differentiate by developing foods that actually respond to consumer needs, without prejudice to consumer protection and security.

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Chapter 3
Diet and Nutritional Requirements

Abstract Nutrition is one of mankind's fundamental needs. He has always been on the lookout for the most suitable foods from both a qualitative and quantitative point of view. With the coming into being of the food industry, the number of food products has progressively increased, and in developed countries, the pace of in-novation is continuously on the rise. On the one hand, such a wide possibility of choice has solved the problem of quantity, but on the other, it does not always prove to be useful in making an optimal choice of food in terms of quality. In the past few years there have been in-depth studies on nutrition in order to understand the effects foodstuffs have on the functioning of the human organism, therefore, the two dietary regimes being food and nutrition, are more and more interrelated. In fact, it is no longer enough to know the characteristics of a foodstuff, but it is necessary to follow the route it sets within our organism so as to be able to free those useful substances, and understand if and in what measure they are used for metabolic scopes. Guidelines on nutrition have progressively evolved with time offering some valid help, while taking into consideration a more and more rapid evolution of nutritional studies. If the freedom an individual has as regards food products is greater and greater, it is also true that each choice is reflected on the state of wellbeing with time.

The Evolution of Food Choices

As time goes on, mankind has learnt to choose the most suitable foodstuffs for his survival. Many decisions have been taken on the basis of experience, and by observing phenomena, and in certain cases, have permitted us to integrate important nutritional principles into a system that was previously unknown, while in other cases, have cost us our life, or have brought about much suffering. However, mankind's ability enabled him to move on from being a hunter to harvesting crops, discovering fire and eventually achieving an Agricultural Revolution after a very long period of time, to starting off cereal cultivation practices and livestock

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breeding. With time, population cultures, alongside habits and political and religious influences, have determined nutrition models that have been implemented up to our day and age. With the development of the food industry, the number of products realized and conservation times have increased notably, up to proposing typologies of foodstuffs with a high innovation content. If on the one hand the first studies at the basis of the transformation and conservation of foodstuffs date back a long time, just consider the studies conducted by Antoine Lavoisier (1743–1794) on energetic metabolism or the introduction of appertization by Vinse Nicolas Appert (1749–1841), a baker who casually started using sealed containers to cook foods in, since he realized how the same foods lasted longer, on the other hand, those related to foodstuffs and their content are much more recent. In the course of history, we can count successes but also errors, like, for example those related to the discovery of vitamins and mineral salts, indispensable substances for the survival of the human organism, but whose theorization of etiology only took place in the course of 1900.[1] Much more recent are studies that evacuate the effects of foodstuffs on mankind's state of health, and therefore nutrition science can only be in constant and continuous evolution. In Italian literature, the terms diet and nutrition are starting to find their own identity, as from the new millennium, even if they commonly continue being inappropriately confused and superimposed. In Anglo-Saxon literature, the two disciplines, food and nutrition, find their own distinct autonomy by really discussing food, when one wants to make reference to the food product, meaning any substance intended for human consumption.[2] Naturally, included in the definition is also chewing gum, and every ingredient or component used for the realization of products (FDA 2006). The study of food comprises the analysis of the nature, origin, quality, safety and conditions of production, use and commercialization.

The term nutrition means the science which interprets the relationship among nutrients and other substances present in foodstuffs, and maintenance of growth and reproduction, or an organism's health status or illness. It includes intake, absorption, assimilation, synthesis, energetic metabolism, catabolism and breakdown of foodstuffs. According to the Committee on World Food Security, nutrition is "the consequence of the intake of food and the utilization of nutrients by

[1]The discovery of vitamins has been subject matter of a succession of errors, due to the fact that their existence was unknown, and also their importance. For example, the discovery of vitamin C (ascorbic acid) is linked to a pathology called scurvy that struck sailors who stayed away from land for long periods of time, eating mainly dried or preserved foods. On the contrary, Vitamin C is present in citrus fruit and green leafy vegetables. Those sailors who were affected by that pathology, showed signs of shaking and jerky movements—from where the name scurvy derives—were kept in quarantine, and therefore, their pathology could only get worse, and even cause death. The problem was solved only by administering small quantities of citrus fruit juice. However, we had to wait for 1753 when the scholar Lind realized that lemon juice seemed to be an effective cure, even if it ignored the reason why the vitamins had not been isolated, and nutrition was considered anchored to macronutrients only.

[2]In actual fact, the term food not only refers to human nutrition but also animal nutrition. For an accurate definition, see the following paragraph.

the body. Good nutrition produces a healthy physical and physiological condition. It is secured when food intake, absorption and utilization provide all essential nutrients in required amounts. Poor nutrition produces an unhealthy physiological condition, and is caused by a lack of physical, economic, social or physiological access to the right amounts of dietary energy and nutrients. Consequences of poor nutrition can impair physical and mental development, reduce immunity, increase susceptibility to disease, decrease ability to work and reduce productivity. Since parasites, poor hygiene and diseases can compromise a person's ability to absorb and biologically utilize the nutrients consumed, a safe food supply, clean drinking water, sanitary environment, adequate health, education and care, are essential for good nutrition, along with a balanced diet. Optimal nutrition supports development in obtaining each individual's full genetic potential" (CSF 2012). In other words, the term nutrition refers to the organism's needs, and the study of the effects on the recipient subject of that which he takes in, in terms of foodstuffs. The two terms are linked by the composition of the diet that each individual chooses on a daily basis, and it is based on a series of traditional foodstuffs, subdivided per category on the basis of origin and composition, or rather, the prevailing nutritional element. The categories of traditional products being:

- milk and derivatives (predominantly sources of protein and calcium);
- meats, fish, by-products and legumes (predominantly sources of protein, vitamins and iron);
- cereals and by-products (predominantly sources of starch, fiber and vitamins);
- condiment fats (predominantly sources of essential fatty acids and vitamins)
- fruit and vegetables (predominantly sources of fiber, vitamins and mineral salts).

In Italy, the nutrition model is predominantly well grounded on principles of the Mediterranean diet, even if in the past few years, the phenomenon of globalization has noticeably reduced territorial diversities, biodiversity and reference to a specific habitat (Lucchin and Caretto 2012). It results in the fact that while maintaining its validity, by virtue of the relationship with the reduction of cardiovascular illnesses, it should no longer be considered an absolute model. The most diffused reference for food choices is surely the Pyramid, worked out by the Food and Drug Administration in 1992, and revised in 2005. In the first version, the products placed at the basis of consumption are those which can be used more frequently, like bread, pasta, rice and cereals, on a higher level, fruit and vegetables, with a slight preference towards the latter, at a higher level still, milk, yoghurt and derivatives, together with meat, fish and nuts, and finally at the top of the pyramid, fats, oils and sweets, to be consumed sparingly. After this first version of the food Pyramid, new versions came into being aimed at introducing physical activity, which if done regularly, makes up an optimal adjuvant in maintaining good health and eliminating the hierarchical structure that is especially disliked by meat producers, milk and derivatives (Welsh et al. 1992; Haven et al. 2006). A brief summary of the nutrition evolution with time, prepared by the United States Department of Agriculture (USDA 2011) is referred to in Table 3.1.

Table 3.1 A brief history of USDA Food Guides

1916–1930s	
“Food for Young Children” and “How to Select Food” Established guidance based on food groups and household measures Focus was on “protective foods”	
1940s	
A Guide to Good Eating Foundation diet for nutrient adequacy Included daily number of servings needed from each of seven food groups Lacked specific serving sizes Considered complex	
1956–1970s	
Food for Fitness, A Daily Food Guide Foundation diet approach—goals for nutrient adequacy Specified amounts from four food groups Did not include guidance on appropriate fats, sugars, and calorie intake	
1979	
Hassle-Free Daily Food Guide Developed after the 1977 Dietary Goals for the United States were released Based on the Basic Four, but also included a fifth group to highlight the need to moderate intake of fats, sweets, and alcohol	

(continued)

Table 3.1 (continued)

1984	
Food Wheel: A Pattern for Daily Food Choices Total diet approach included goals for both nutrient adequacy and moderation Five food groups and amounts formed the basis for the Food Guide Pyramid Daily amounts of food provided at three calorie levels First illustrated for a Red Cross nutrition course as a Food Wheel	
1992	
Food Guide Pyramid Total diet approach—goals for both nutrient adequacy and moderation. Developed using consumer research, to bring awareness to the new food patterns. Illustration focused on concepts of variety, moderation, and proportion. Included visualization of added fats and sugars throughout five food groups, and at the tip. Included a range for daily food amounts across three calorie levels	
2005	
My Pyramid Food Guidance System Introduced alongside updating of Food Guide Pyramid food patterns for the 2005 Dietary Guidelines for Americans, including daily food amounts at 12 calorie levels. Continued "pyramid" concept, based on consumer research, but simplified illustration. Detailed information provided on website "MyPyramid.gov". Added a band for oils and the concept of physical activity. Illustration could be used to describe concepts of variety, moderation and proportion	

(continued)

Table 3.1 (continued)

2011	
MyPlate	
Introduced along with updating of USDA food patterns for the 2010 Dietary Guidelines for Americans	
Different shape to help grab consumers' attention with a new visual cue Icon that serves as a reminder for healthy eating, not intended to provide specific messages	
Visual is linked to food and is a familiar mealtime symbol in consumers' minds, as identified through testing	
"My" continues the personalization approach from My Pyramid	

Source http://www.choosemyplate.gov/food-groups/downloads/MyPlate/ABriefHistoryOfUSDAFoodGuides.pdf

The food guidelines suggest the optimal way of including foods in a daily diet system, but we should not forget that purchasing is influenced by multiple socio-demographic and cultural variables, the first being that we are reminded about the increase in average life expectancy of individuals, which pushes towards food-stuffs with a high healthy content, the change in family structure with the progressive reduction of components that induced to purchasing single serving packages and foods with a high service content. There are also changes in work models, dual career families, longer and longer travelling times involving a reduction in the time taken up for cooking, and a de-responsibilization of the feminine figure in managing shopping needs and preparing meals. Finally, the ever increasing phenomenon of migration influxes brings about a multi-varied ethnic composition, with a progressive impact on the diffusion of innovative products (cous cous, kebab, kamut, etc.). From a socio-cultural point of view, the influencing factors are adhering to new and more sustainable models of consumption, which foresee the choice of biological products, at zero km—local production, in other words, typical to fair trade. Even the search for a subjective wellbeing brings about a change in food choice, driving the consumer towards quality products with a high nutritional content (nutraceutical, functional, etc.) in search of material wellbeing. The immaterial values are based on hedonistic levers, of belong-ing, experiences of high symbolic value, and drive one to choosing selected foods, such as, for example slow food or defence foods (Bittner and Kulesz 2015). Finally, there is a whole series of individual factors of a sensorial origin, nutritional, and of a psycho-physiological nature, linked to the organoleptic characteristics of the foodstuff, in other words, the marketing and health levers. On the basis of ever increasing requests from consumers and new nutrition needs, the food industry has studied and put into production lighter foods, or foods with a reduced content of substances considered harmful to our health, and it has created new more and more elaborate food categories, ranging from light food to strength acquiring foods, from functional new generation neutracetics which will find proper collocation in schemes, and nutrition guides with time. (Nestle 2013).

The Meaning of the Term "Diet"

The term diet derives from the Greek *δίαιτα (dìaita)*[3] meaning "kind, diet, lifestyle" and indicates the composition of foodstuffs on man's side, able to satisfy specific energetic and nutritional needs. With time, the term took on different meanings, and can be used to indicate a limitation of nutrition intake to obtain weight reduction (low-calorie diet), a reduction of a few substances having a therapeutic scope (low-salt diet), a typology of foods that a person habitually consumes (vegetarian or vegan diet), in other words, addition of calories or specific elements (high-calorie or high-calcium diet). In developed societies, the topic of nutrition has become subject matter for special attention in relation to needs, which can guarantee populations and single individuals the highest level of wellbeing, considering the diffused abundance of foods on the one hand, and the need to use them properly on the other, so as to avoid pathologies linked to overeating. For this reason, the present volume insists on evaluation modalities of individual needs in the first part, to subsequently placing them into a system with availability in the market, offered on a daily basis by the food industry, and evaluating how and in what measure existing products are able to respond to real needs of every individual, the term diet will be used as a synonym to a proper healthy and balanced nutrition.

From "Food" to "Nutrition Principles" and "Nutrient"

To feed himself, man takes resources from the natural environment of which he is part. The link between man and nature is very close and exposed to natural cycle trends, seasonal and weather patterns. In industrialized countries, food availability does not constitute a limiting factor since intensive breeding and farming techniques, together with improvement of conservation methods have permitted to obtaining the necessary quantity to satisfy population needs, apart from the seasonal nature of production. In case of insufficient availability of food, an intense import flow by producer countries is foreseen. Therefore, we can distinguish two fundamental concepts, food security, intended as the need to guarantee populations sufficient access to food availability, linked to the quantitative disproportion between North and South in the world, defined by FAO as "A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences

[3]The Oxford Dictionary defines the term diet as "the food that you eat and drink regularly" and "a limited variety or amount of food that you eat for medical reasons, or because you want to lose weight", Oxford Dictionary, available at: http://www.oxforddictionaries.com/definition/learner/diet. An analogous definition is found in Cambridge Dictionaries available at: http://dictionary.cambridge.org/dictionary/british/diet.

for an active and healthy life. Based on this definition, four food security dimensions can be identified: food availability, economic and physical access to food, food utilization and stability over time)", and food safety, to be interpreted as the need to guarantee the non-toxicity of foodstuffs along the entire production chain where chemical, physical or biological may occur, a problem that is even more felt in globalized food contexts. In the last few years, the concept of nutrition security has been added, defined as "A situation that exists when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, in order to ensure a healthy and active life for all household members. Nutrition security differs from food security in that it also considers the aspects of adequate caring practices, health and hygiene, in addition to dietary adequacy" (CSF 2012). The availability of foodstuffs affect consumer choices, conditioned by factors of an objective nature, like for example physiological aspects regarding the need to ascertain a nutritional intake for survival, and the possibility of having access to traditional and innovative foods, as well as those of a subjective nature, such as psychological ones determined by taste, pleasures of the table, cultural, social and economic convictions (Jabs and Devine 2006; Cruwys et al. 2015). In developed countries, excessive availability of foods, and the high rate of innovation do not always make purchasing choices easy, and as far as the Italian one is concerned, we have witnessed a progressive abandonment of a Mediterranean diet to favour a continental diet, with a progressive increase in illnesses linked to nutrition. The study of the relationship between food and how it affects our organism will have to keep track of the intake of nutrients, but without separating them from the typology of foods chosen, from an overall diet and individual lifestyle. It is necessary to remember that a complete food does not exist in nature, able to fulfill all of an organism's needs (from children to senior adults), and therefore diet composition (food choice) is an assumption that cannot be disregarded to guarantee a good state of health and wellbeing. Furthermore, in their composite structure, foods may contain substances that carry out a positive or a negative function, in terms of usefulness. Among the first, classified nutritional principles will be counted, as we will see further on, in the two categories of macro and micronutrients. Among the second, we include substances that are able to hinder or slow down some basic functions, as for example enzymatic inhibitors, anti-vitamins and absorption reducers of nutrients, and in a wider sense, also toxic ones, such as in the case of particular toxins contained in certain fish and/or mushrooms. Finally, the foodstuff may set up the ideal vector for transportation of harmful pollutants, as in the case of eggs containing the salmonella germ, or certain fish with a high mercury content, or rather, certain technologically modified organisms obtained with productive processes, such to transform the raw material in food substantially far from what nature offers. In order to understand the food path from being taken into being used by an organism, it is necessary to explain the difference between foodstuff, nutritional principle and nutrient. For foodstuff in general, we mean a substance or compound containing nutrients which are released during the digestive process. The etymology of the word is derived from the Latin "alere" meaning feeding,[4] term which is obsolete in common language. The first definition of foodstuff as provided by the Italian system is found in D.M. 31 March 1965, regarding the discipline of chemical additives allowed in the preparation and preservation of food substances. In Article 2,we read that "In the scope of the present decree, with the term "foods" we mean food substances, food products and beverages, as well as preparations to be chewed or sucked, like "chewing-gum" and such like". A really ample definition derives from this to justify the legislative intention in order to safeguard safety of everything that could be occasionally taken in. Nowadays the recognized definition at European level is that of Codex Alimentarius that defines food as "any substance, whether processed, semi-processed, or raw, which is intended for human consumption, and includes drink, chewing gum and any substance which has been used in the manufacture, preparation or treatment of "food" but does not include cosmetics or tobacco, or substances used only as drugs. (FAO/WHO 2013, p. 22). A further definition is the one given by Regulation (CE) n. 178/2002 of the European Parliament and Council of the 28th January 2002 which establishes the principles and general requisites of the food legislation, establishes the European Authority for food safety, and sets procedures in the field of food safety (European Parliament and Council 2002). Article 2 decrees that "what is intended by "food" (or "food product", or "foodstuffs") is any substance or product transformed, partially transformed or not transformed, bound to be taken in, or which we reasonably foresee could be taken in by human beings. Included hereto are drinks, chewing gum and any substance, including water, intentionally incorporated in foods in the course of their production, preparation or treatment.[5] The following are not included: (a) feedstuffs; (b) live animals, unless prepared by introduction into the market for the scope of human consumption; (c) vegetables before being harvested; (d) medicines according to Council directives 65/65/CEE (1) and 92/73/CEE (2); (e) cosmetics ac-cording to directive 76/768/CEE of the Council (3); (f) tobacco and tobacco products according to directive 89/622/CEE of the Council (4); (g) drugs or psychotropic substances according to the unique convention of the Unites Nations on drugs in 1961 and the convention of the United Nations on psychotropic substances in 1971; (h) residues and pollutants. The finality of the European Regulation (CE) n.178/2002 is sanctioned in article 8 which confirms that "food legislation intends to safeguard consumer interests and wants to construct the basis to allow same to carry our conscious choices in relation to foods being the subject matter of consumption". In order to be able to carry out conscious choices, the consumer should know useful substances, the necessary quantity and quality to the proper functioning of an organism as well as modalities of decomposition and use of foods that

[4]It is curious to remember how the word "alunno" (pupil) also derives from the same food etymology, "alere", in Latin and the person who was raised and fed in a cultural sense, thanks to the care of his teacher (Gianni 1989).

[5]The European Regulation (CE) n. 178/2002 includes water in points where values are to be respected as established in article 6 of the 98/ 83/CE directive, save the requisites in directives 80/778/CEE e 98/83/CE.

correlate to the metabolic importance of the nutrient. Vitally important to the state of an individual's health is the contribution of nutritional principles, subdivided into two categories of macronutrients (glucides, protides and lipides), and micronutrients (mineral salts and vitamins). As nutritional principle, we define every complex substance naturally contained in foods which cannot be used if not split and calculated before-hand in order to obtain nutrients. Glucides, protides and lipides are an example. Following the appropriate elaboration, from the nutritional principle we obtain the nutrient which is defined by Codex Alimentarius in the Guidelines on food labeling (CAC/GL 2-1985, rev. 2013) as every substance consumed normally as component of a food product:

- which brings energy;
- which is necessary to growth, development and life maintenance;
- whose lack will cause changes in biochemical or physiological characteristics of an organism.

We can affirm that a nutrient is a substance that can be absorbed as such by an organism, and used for nutritional scopes (energetic, plastics, balancing, regulating or protection)—or rather, to pursue the pre-established metabolic integrity—and are distinguished into energetic and non-energetic, in macronutrients and micronutrients. The passage of the food to the nutrient is explicit, with a few examples in Table 3.2.

The presence of nutrient in the food is a necessary condition, but is not sufficient to the process of absorption and use of same by an organism. The macro and micro nutrients, in fact, are almost never completely usable for activities of the organism's growth and maintenance, and for this it is necessary to introduce the concept of bioavailability defined as "the efficiency with which a dietary component is used systemically through normal metabolic pathways" (Aggett 2010). Bioavailability is measured as the percentage of nutrient used on the total nutrient in-take—it is expressed as a percentage of intakes and is known to be influenced by dietary and host factors—and depends on three typologies of factors: the characteristics of the food, the composition of diet and intrinsic factors to the individual. As far as the characteristics are concerned, the food may present itself in the most differentiated chemical-physical forms that influence the organism's ability to absorb and make use of the nutrient contained therein. An explicative example is made up of iron, an indispensable element to the metabolic functioning that is found in foods in two forms: hemic and non-hemic. The first is found mainly in animal meats and has a highly efficient absorption process and a variable bioavailability from 15 to 35 % but not influenced by factors related to diet. The second is

Table 3.2 Example of the passage of a foodstuff to the nutritional principle to the nutrient

Foodstuff	Nutritional principle	Nutrient
Pasta	Starch	Glucose
Extra virgin Olive Oil	Triglycerides	Lineic acid
Reggiano Parmesan cheese	Protein	Leucine

found mostly in foods of vegetable origin, in eggs and dairy, and presents a very low bioavailability, around 2–10 %, whose variability is to be correlated to diet composition. In fact, depending on how the meal is made up, elements that favour or rather that inhibit the intake of nutrients can reach the organism. The assimilation of non-emic iron is favoured by the co-presence of ascorbic acid—commonly contained in citrus fruit—while it proves to be inhibited by substances like tannins (present in red wine), other polyphenols (contained in coffee and tea), calcium, certain proteins (such as for example those of soy and walnuts) and food fibers. Finally, bioavailability is influenced by factors intrinsic to the individual and are to be ascribed to mechanisms of a gastric emptying, to the production of enzymes, to the time of digesting the foods, to the areas of absorption and physiological state, nutritional and health which characterize it (Heaney 2001). Starting from the food and the proper supply and balance of correlated nutrients to what the body needs, an optimal state of nutrition can be derived. On the contrary, every time there occurs an intake of inappropriate nutritive substances to real organism needs, there could be a situation defined as “inconsistent nutrition” (Vannozzi et al. 2009) by defect or excess.

Conclusion

The food guidelines suggest the modality of composition of daily diet to make optimal choices in relation to maintaining an organism’s healthy state and wellbeing as long as possible. It is understood that useful substances are classified into two categories of macro and micronutrients. Said classification is not exhaustive of what the organism really needs. In fact, the passage of the foodstuff to the nutritional principle and finally the nutrient is very long and complex. Furthermore, not all nutrients can be used by the organism since they appear in different forms that affect bioavailability. In this first chapter, key concepts have been analyzed which bind food choices, made by each consumer, to the more reliable indications that guide diet composition up to pinpointing the mechanisms that regulate the passage of the foodstuff to the useful substances. It is understood that it deals with an exposure with a high degree of simplification to guarantee comprehension by each and every reader.

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Chapter 4
Factors Influencing Energy Balance: Estimation Methods

Abstract The human organism is a chemical machine in that it is only able to use chemical bond energy obtained from the oxidation of energy substrates supplied by food and converted for the performance of all the vital functions. It is very important for an individual to know his daily energy requirements because this constitutes the starting point for the creation of an optimal diet. We must distinguish between calorie intake, consisting of what is introduced daily with food intake, energy expenditure related to all the voluntary and involuntary activities carried out by the individual, and finally his energy requirements which are closely related to expenditure. An individual's energy expenditure depends on three factors: basal metabolism, dietary-induced thermogenesis and physical activity. Quantifying energy expenditure is the starting point for determining energy requirements. Consequently, nutrition is a mathematical equation, if intake exceeds expenditure the body gradually gains weight, on the contrary, if intake is lower the body loses weight. A healthy body should maintain a desirable weight over time in order to maintain all its vital functions as long as possible.

Catabolic and Anabolic Reactions

The human organism is called heterotrophic, a term that derives from the Greek *héteros* which means "other, different" and *trofo* meaning "that is nourished", i.e. it needs to take essential nutrients for its energy supply from an external source unlike autotrophic organisms, from the Greek *autós* which means "same", such as plants, which are capable of synthesizing the molecules necessary for their metabolism by taking energy directly from the sun. To survive, heterotrophic organisms use autotrophic organisms, which are their source of nourishment. The decomposition of foods is a chemical process necessary to isolate and/or construct nutrients and release energy. The human organism is therefore a chemical machine, which uses the splitting of chemical bonds for energy. So we are neither thermal nor

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electrical machines.[1] There are two types of chemical reaction that occur in our body: *catabolic and anabolic,* and they are closely related to each other. In catabolic reactions complex molecules are reduced to simple molecules by means of a sequence of spontaneous reactions which release energy. These reactions are called exergonic because the energy content of the products obtained is less than that of the reactants as this energy is released to the outside. In anabolic reactions, on the contrary, simple molecules join to form complex molecules. In order to take place, these reactions require energy and so they are called endergonic because the energy content of the products is greater than that of the reactants as energy is absorbed from the outside. Anabolic reactions therefore cannot take place spontaneously and specific mechanisms are necessary to ensure activation. The problem arises from the fact that energy requirements do not always coincide with the phase of energy creation. To explain this in very simple terms it is possible that the intake of food occurs at a moment in time other than when the body actually requires energy. For example, the energy acquired during lunch may be needed in the late afternoon for a sporting activity. How can we guarantee the energy necessary for the anabolic phases which occur at a different time and later than the catabolic phases? The extraordinary functional capacity of our body has devised a system known as coupling or biological stratagem with which it manages to find energy even in the absence of a catabolic phase. This consists in accumulating the energy released by the spontaneous reactions in stable high-energy bonds, whose most important molecule is adenosine triphosphate or ATP, which is a real energy reserve ready for use when the body needs it. In this way, the energy released by catabolism is in fact transferred to anabolism. An example of catabolic reaction is the demolition of glucose while the synthesis of glucose is anabolic. Energy is the human body's primary requirement and in the following section we will describe the most reliable methods for the calculation of individual requirements.

Energy Requirements and a Comparison Between the Main Estimation Methods

We can distinguish an individual's energy requirements, energy expenditure and energy intake which together form his/her overall metabolic equilibrium. Daily energy requirement can be defined as "the quantity of food derived energy necessary to offset the energy expenditure of an individual who does sufficient physical activity to participate actively in social and economic life, and whose body has dimensions and composition compatible with a good state of health" (FAO and United Nation University 1985; LARN 1996). A more recent definition states that energy requirement is the amount of food energy needed to balance energy

[1] Certain body processes are of an electrical or thermal nature but these represent a minimal and negligible part of total energy functions.

expenditure in order to maintain body size, body composition and a necessary and desirable level of physical activity consistent with long-term good health and that will allow for the necessary maintenance of economically and sociably desirable physical activity (FAO 2004). Of course energy requirements may vary according to an individual's particular moment in life, that is to say growth phase, pregnancy or breastfeeding. Energy requirement is closely related to energy expenditure, defined as the energy released by the body as heat and the energy necessary to carry out the mechanical work required by his/her lifestyle (Seale 1995). It consists in the transfer of energy from the body to the external environment and in the case of man it is governed by the principles of thermodynamics. Energy expenditure is calculated on the basis of the following factors:

- Basal metabolism;
- Dietary-induced thermogenesis;
- Physical activity.

Basal metabolism is the minimum rate of energy required by the body at rest to carry out the activities necessary for the maintenance and functioning of the tissues. In other words it is the amount of energy used by an individual at rest, in a neutral thermal state[2] who hasn't eaten for 12–14 h, and is in a state of total physical and psychological relaxation.[3] The BMR of an individual can simply be defined as the minimum metabolic activity required to maintain life and is a major component of total energy expenditure, whether the individuals are sleeping, resting or working (Payne and Waterlow 1971). BMR is measured under standardized resting conditions: bodily and mentally at rest, 12–14 h after a meal and in a neutral thermal environment (Ismail et al. 1998, p. 82). However in practice it is far more difficult to achieve the conditions of 'basal metabolism' than it is to define them (Garrow 1978). In fact, metabolic energy has the task of performing all the involuntary activities that do not depend on the individual such as blood circulation, maintenance of body temperature, respiration, the nervous system and tissue renewal. Basal metabolism absorbs between 60 and 75 %, variable from individual to individual, of the total energy requirement. Dietary-induced thermogenesis (DIT) is the increment in energy expenditure above resting metabolic rate associated with the cost of absorption and processing of food for storage (Denzer and Young 2003). It's the energy used for the digestion, absorption and distribution of

[2]We speak of thermal neutrality when the individual presents no heat exchanges and the external temperature is between 26 and 30 °C. It goes without saying that if the temperature increases or decreases the body will be subject to a greater energy expenditure.

[3]Other definitions are given by the American Heritage Dictionary of the English Language, Fifth Edition. 2011 where Basal Metabolism is referred to as "the rate at which energy is used by an organism at complete rest, measured in humans by the heat given off per unit time, and expressed as the calories released per kilogram of body weight or per square meter of body surface per hour" and by the Dictionary.com website: http://dictionary.reference.com/browse/basal, retrieved May 19, 2015, which states that "metabolism is the minimal amount of energy necessary to maintain respiration, circulation, and other vital body functions while fasting and at total rest".

nutrients and it is also called the thermic effect of food (TEF) or specific dynamic action (SDA).[4] It absorbs between 7 and 13 % of total energy expenditure and changes according to the type and quality of food ingested. The thermogenic stimulus linked to the intake of carbohydrates varies between 5 and 10 % of the energy ingested while it is much higher for proteins, between 10 and 35 %, because they need a very long digestive process due to nitrogen removal, urea synthesis and gluconeogenesis.[5] A lower expenditure is related to fats, between 2 and 5 % of the energy ingested, which once ingested have fairly direct storage deposit routes. The variability of expenditure also depends on the type of process activated in relation to the specific needs of the body. Certain substances, such as coffee, tea, tobacco, concur in increasing energy demand and the extent of this demand depends on the amount consumed (Collins et al. 1994). For example, the daily consumption of a packet of cigarettes results in an increase in energy expenditure of 150–200 kcal. Additional energy is required to perform any physical activity linked to muscular movement (standing up, walking, running, lifting weights, etc.) and is closely dependent on the type, frequency and intensity of the physical exertion. It varies from 15 to 30 % of total energy expenditure but can reach values equal to 3–4 times basal metabolism for very intense sporting activities such as those performed by certain athletes or in particularly strenuous professional activities. The value that is obtained from the sum of the three components of expenditure represents the total energy expenditure of an individual and is expressed in quantities of energy (or work) per unit of time and the unit of measurement is represented by the kilocalorie (kcal) or kilojoules (kJ). The kilocalorie is a unit for measuring energy, expressed as the quantity of heat necessary to raise a kg of distilled water by one degree centigrade, from 14.5 to 15.5 °C, at a pressure of one atmosphere.[6] The joule is a unit of energy expressed as the amount of work done when applying a force of one newton to move a body through a distance of 1 m. The International System of Units has established the joule as the standard unit of energy while in the Italian system both units are used (kcal and kJ). 1 joule (J) is the amount of mechanical energy required to displace a mass of 1 kg through a distance of 1 m with an acceleration of 1 meter per second ($1\ J = 1\ kg\ m^2 \times 1 \times 1\ s^{-2}$). Multiples of 1,000 (kilojoules, kJ) or 1 million (megajoules, MJ) are used in human nutrition. The conversion factors between joules and calories are: 1 kcal = 4.184 kJ, or conversely, 1 kJ = 0.239 kcal. It is easy to switch from one to the other using the appropriate conversion factors as 1 kcal corresponds to 4.1868 kJ while 1 kJ

[4]Other terms used as synonyms for the thermic effect of food are post-prandial effect (PPT), thermic effect of meal (TEM) and diet-induced thermogenesis (DIT).

[5]This is the main reason justifying scientific research into the correlation between high-protein diets, the acceleration of thermogenesis and subsequent weight loss.

[6]In the past, the Cal or large calorie was used as a measuring unit for food energy, corresponding to 1 kcal or 1,000 small calories (cal).

corresponds to 0.2388 kcal.[7] The total expenditure of an individual varies between 2,000 and 5,000 kcal for a man and between 1,700 and 3,500 kcal for a woman. The variation is closely correlated to the following factors of influence:

- Height and physique, expressed by weight;
- Sex;
- Age;
- Other factors.[8]

Weight is directly proportional to energy expenditure and in fact when the former increases so does the latter as the exertion required to maintain and move the body is higher. With reference to basal metabolism, it can be observed that the vital organs consisting of the heart, liver, brain, and kidney, which constitute only 5.5 % of body weight, have a basal calorie expenditure of about 60 %. Muscle mass, which constitutes about 40 % of body weight accounts for only 22 %, fat tissue is less energy-intensive, because while constituting approximately 21 % of body weight, it consumes only 4 % of basal energy (Elia 1992).[9] The second factor of influence, sex, is related to the fact that men have a higher lean body mass than women, both in percentage and absolute terms and thus with other conditions (weight and age) being equal, the basal metabolic rate of a woman per kg of body weight will always be lower. With age, basal metabolism undergoes some changes: in the elderly it tends to decline rapidly and therefore the value is lower than that present in young people. Some studies (Keys et al. 1973; Ferro-Luzzi et al. 1988; Food and Nutrition Board and Institute of Medicine 2002) showed a reduction in basal metabolic rate with increasing age of about 1–2 % per decade, with a 10 % variation between subjects, due to genetic differences. In children, on the contrary, there is a high basal metabolic rate due to the formation of tissues during the growth process. Among the other factors affecting energy expenditure we can find emotional upset, stress, hormones, variations in temperature either in the body or in the environment, and taking medicine. Finally, we have energy intake, which corresponds to the quantity of energy which the individual acquires in relation to the composition of his diet. In some studies it has been used as an indicator of the overall energy requirements of an individual with a weight and body composition that is constant over time (Seale 1995). However, the use of energy intake alone, based on ingested food, cannot be considered an optimal indicator for the assessment of overall expenditure since it takes no account of changes in energy reserves.

[7]The following example can facilitate the use of the two units of measurement used in the food industry: 12 kcal correspond to 50.241 kJ (12 kcal × 4.1868) and 12 kJ are equivalent to 2.866 kcal (12 kJ × 0.2388).

[8]For further information on the calculation of the average requirement in relation to age, sex and intensity of physical activity. See EFSA (2013).

[9]This refers to a basal metabolism value equal to 1.680 kcal per day, calculated on an average 30 year-old male adult with a BMI of 22.5 kg/m^2.

Energy balance is achieved when the energy introduced with food consumption corresponds to daily expenditure. In the case where intake exceeds expenditure the individual will gradually gain weight, in the opposite case—the energy introduced is less than that consumed—after an initial reduction in energy reserves we will have a more or less serious case of malnutrition depending on the entity and the duration of the deficit. It is therefore of paramount importance to know on the one hand the energy requirements of the individual in order to choose and create an optimal diet and ensure well being as long as possible. The calculation of the energy requirements of an individual is based on energy expenditure. To calculate energy expenditure, calorimetric methods may be used, with direct or indirect measurements of energy, as well as non-calorimetric methods. Among the former there is direct calorimetry which measures the heat released by the body and is based on the principle that all the energy consumed by the body to perform work is returned in the form of heat. The limitation of this method consists in the fact that each body has the ability to accumulate or lose heat and consequently there may not be a perfect correspondence with the measurement of heat losses. Indirect calorimetry is based on the assumption that the decomposition of food consists of redox reactions that use oxygen and release carbon dioxide in proportion to the energy generated. Ultimately, the method is based on determining respiratory gas exchange for limited periods of time to measure the oxygen consumed and to obtain the amount of energy produced as well as the nitrogen used for protein formation. With the use of specific equations, it is possible to calculate energy expenditure (Weir 1949).

The non-calorimetric methods are based on specific equations which take into consideration the factors which influence energy expenditure and which will go to form the essential parameters for evaluation.[10] Below we analyze the main equations used in the field of food and nutrition. The main equations that can be used to calculate energy requirements are the following:

1. Harris and Benedict (1918);
2. Roza and Shizgal (1984);
3. Mifflin-St Jeor et al. (1990);
4. Cunninghum (1980);
5. Schofield (1985);
6. Santoprete (1995);
7. Institute of Medicine (2005).

There is actually a very simplified formula that quickly calculates individual requirements. However, it is highly criticized by nutritionists precisely because of the excessively simplified nature of the calculation, and therefore, it can only be considered as a starting point for the analysis of energy requirements.

[10]The evaluation of energy expenditure can be performed on individuals, on specific groups (e.g. where people are under or overweight) or on a particular population. In the present volume reference will be made only to the equations which can be applied for individuals.

$$\text{Men}\, E\ (\text{kcal/day}) = H \times H \times 600 \tag{4.1}$$

$$\text{Women}\, E\ (\text{kcal/day}) = H \times H \times 600 \tag{4.2}$$

where E is the energy needs, H is the height in metrer.

To give an example, a man who is 1.85 m tall, will have an energy requirement of 2258.85 kcal per day, while a woman who is 1.65 m tall will have an energy requirement of 1633.50 kcal per day. As height is the only factor taken into consideration this formula may not present accurate results. For this reason far more analytical equations have been elaborated and now we will briefly describe their main characteristics and application methods.

The Harris–Benedict Equation

The Harris–Benedict equation takes into account all the factors which influence energy requirement and divides the calculation into two parts: the first devoted to measuring the basal metabolic rate and the second to integrating the energy value resulting from physical activity. In order to calculate the basal metabolic rate it is necessary to know an individual's sex, weight, height and age, related to each other by the following equations.[11]

$$\begin{aligned}\text{For men, BM (kcal/24 h)} = {} & 66.47 + (13.75 \times \text{Weight}) + (5.00 \times \text{Height}) \\ & - (6.75 \times \text{Age})\end{aligned} \tag{4.3}$$

$$\begin{aligned}\text{For women, BM (kcal/24 h)} = {} & 655.09 + (9.56 \times \text{Weight}) + (1.85 \times \text{Height}) \\ & - (4.67 \times \text{Age})\end{aligned} \tag{4.4}$$

Weight is expressed in kg, height in cm and age in years. If we consider an average male with a weight of 70 kg, a height of 175 cm and aged 30 we will have a BM of 1.701 kcal whereas a female with the same characteristics will have a BM of 1.518 confirming the fact that all conditions being equal the metabolism of a man is greater than that of a woman due to the different arrangement of lean body mass in the body. The equation we have just analyzed tends to overestimate the basal metabolic rate by at least a 5 % (Frankenfield et al. 1998) and for this reason it has been replaced by subsequent equations. In addition, to complete the calculation of overall energy requirements (Resting Energy Expenditure, REE) it is necessary to add the energy expenditure value due to movement. Since each activity

[11]In 1981 the equation was revised and an addition made in order to calculate the basal metabolism of children (Caldwell and Caldwell 1981). For the sake of completeness, we include it here: For children, BM (kcal/24 h) = 22 + (31.05 × Weight) + (1.16 × Height).

performed by an individual has a different and specific energy cost it will be necessary to make an assessment of his average day in order to assign each activity with its corresponding energy expenditure. Of course, in the absence of detailed information about an individual's behaviour we can base our calculation on estimates taken from studies in the literature (FAO 2004). The energy cost resulting from the various activities an individual can perform throughout the day can be calculated in two ways:

- as a multiple of the Metabolic Equivalent of Task (MET) corresponding to the amount of energy required at rest and expressed as the volume of oxygen consumed in a time unit per kg of body weight (ml/min/kg)[12];
- as a multiple of Basal Metabolism (BM), this method is used most because it frees the calculation from individual differences in weight and body composition.[13]

Both parameters are based on the assumption that at the lowest level the expenditure value will correspond to the MET or the basal metabolic rate. It is necessary to calculate the multiplicative coefficients to determine the energy expenditure in proportion to them. With reference to the second, more common method, it is necessary to introduce the Physical Activity Ratio (PAR), which expresses the increase in energy expenditure caused by a particular activity compared to the basal metabolic rate. For example, a PAR equal to 2 expresses an energy cost of twice the basal metabolism. So a man with a BM equal to 0.90 kcal/min will have an energy cost for physical activity equal to 0.90 × 2 or 1.8 kcal/min). The PAR is expressed as follows:

$$\mathrm{PAR} = \mathrm{EE}_{\text{attività}}(\mathrm{kcal/min})/\mathrm{BM}\ (\mathrm{kcal/min}) \tag{4.5}$$

The energy costs of some activities, reported in the Table 4.1, are taken from data compiled by the FAO in 2004 and provide a breakdown according to categories such as general personal activities, the use of transport, activities involving weight-lifting, housework, agriculture, the work carried out in certain professions, in sports or recreational activities.

The sum of daily energy expenditure for all the activities enables us to move on from PAR to PAL, Physical Activity Level, which reflects the intensity of an individual's energy expenditure. The analysis of the whole day is important because

[12] 1 MET corresponds to 3.5 ml of O_2/kg body weight/minute equal to 0.01768 kcal/kg of body weight equivalent to about 1 kcal/kg body weight/hour. The caloric equivalent would be that 1 liter of O_2 corresponds to 5 kcal. For example, a man weighing 70 kg will have a MET of 3.5 ml O_2 × 70/min = 245 ml O_2/min, equivalent to 1.680 kcal per day.

[13] The Joint FAO/WHO/UNU Expert Consultation on Energy and Protein Requirements concluded that there would be many advantages in expressing the various components of total energy expenditure (TEE) as a multiple of the basal metabolic rate (BMR). BMR is the most dominant component of TEE, and this is the primary reason for expressing the energy requirement (primarily BMR plus energy requirements for physical activity) as a multiple of the BMR.

Table 4.1 Energy costs of some activities expressed as a physical activity rate (PAR) and subdivided for males and females

Type of activity	Males	Females
Sleeping	1.0	1.0
Dressing	2.4	3.3
Eating and drinking	1.4	1.6
Walking slowly	2.8	3.0
Walking uphill	7.1	5.4
Walking downhill	3.5	3.2
Cycling	5.6	3.6
Riding a motorbike	2.7	–
Driving a car	2.0	–
Peeling vegetables	1.9	1.5
Shopping	–	4.6
Childcare	–	2.5
Ironing	3.5	1.7
Hoeing	4.2	5.3
Writing	1.4	1.4
Football	8.0	–
Tennis	5.8	5.92
Swimming	9.0	–
Dancing	5.0	5.09
Playing piano	2.25	–
Watching tv	1.64	1.72

it is possible that an individual with a sedentary job plays a strenuous sport as opposed to an individual with a physically demanding job who spends his free time on sedentary activities. By calculating the time-weighted averages of PARs we obtain PAL:

$$\mathrm{PAL} = (\mathrm{par1} * t1 + \mathrm{par2} * t2 + \cdots + \mathrm{parn} * tn)/(t1 + t2 + \cdots + tn) \tag{4.6}$$

where t represents the time spent on the single activities of the day, from 1 to n. PAL expresses energy expenditure in 24 h and is expressed as a multiple of BM.

$$\mathrm{PAL} = \mathrm{EE24ore/BMkcal/day} \tag{4.7}$$

To achieve a more accurate calculation it is possible to use integrated energy indices (IEI) instead of PARs, which describe the energy cost of specific occupations as a ratio of the BMR. This value is weighted for pauses in activity and integrates the cost of various tasks. Thus, a domestic helper's IEI specifies the energy spent over the whole work shift while carrying out an appropriate variety of specific tasks (cooking, washing, ironing, etc.) and having a number of interspersed periods of rest. Likewise, an athlete who trains 2 h in the gym will do some exercises interspersed with preparation, breaks, shower, etc. which do not have the same energy expenditure. In Table 4.2 some integrated energy indices are reported for some activities.

Table 4.2 Integrated Energy Indices (IEI) for some activities

	IEI		IEI
Personal Care		*Leisure*	
Personal hygiene	2.50	Sport	6.00
Meals	1.50	Religious activity	1.80
Sleeping	1.00	Walking	2.00
Work activities		Walking briskly	4.00
Teachers	1.60	Reading	1.10
Office workers	1.6	Watching TV	1.10
Shop assistants	2.2	Going to public places	1.50
Home care	2.50	Hobbies	1.80
Childcare	3.00	Spending time with friends	1.40
Shopping	2.50	Socially useful activities	1.80

Source LARN (1996)
M Male, *F* female

On the basis of the elements described above it is possible to reconstruct an individual's typical day and calculate his physical activity level over a 24 h period. That value can then be multiplied by the BM to give a sufficiently precise evaluation of total daily energy expenditure. Table 4.3 illustrates the calculation of the energy requirements of a 20 year-old female, weighing 58 kg, 165 cm tall who works in an office.

To obtain the values reported in the table it is necessary to calculate the basal metabolism of the individual under observation. By applying the Harris–Benedict

Table 4.3 Example of an energy expenditure calculation for an adult

Activity description	IEI	Working day		Day of rest	
		Hours	kcal	Hours	kcal
Rest	1.00	8	474	8	474
Work activities					
Home care	2.5	1	148	2	296
Child care	3.0	1	178	2	355
Office work	1.6	8	758	0	0
Discretionary activities					
Physical activity	6.0	1	355	1	355
Shopping	2.5	0	0	2	296
Community work	1.8	1	107	1	107
Rest of the day	1.4	4	332	8	663
Calculation of energy expenditure					
Daily PAL	1.65			1.79	
Energy expenditure	2.352			2.546	

equation you obtain a value of 1,421.42 kcal/day. Dividing the value by 24 we obtain the average hourly basal metabolic rate (59.23 kcal/h). Multiplying the hourly basal metabolic rate by the weight and duration of the activity you obtain the corresponding energy expenditure. For example, at rest you will have: $59.23 \times 1 \times 8 = 474$ kcal. The calculation of the daily PAL is obtained by time weighting as described above. Given that working activity is carried out 5 days a week it is possible to weight the relative weight of the 2 days considering a 65 % weight for the days dedicated to work (5 days a week for 11 months) and a 35 % weight for the days dedicated to leisure (2 days a week for 11 months and 7 days a week for a month). The result is a weighted average PAL ($1.65 \times 0.65 + 1.79 \times 0.35 = 1.70$) from which it is possible to calculate the daily energy requirements weighted for the full year ($1{,}421.42 \times 1.70 = 2416.41$ kcal/day). To conclude the application of this equation we can take the example of a 30 year-old man weighing 70 kg, with a height of 175 cm, and a metabolism of 1.701 kcal/day. If we consider a PAL of 1.4, total energy expenditure will be 2.381 kcal. In the case of a woman of a similar build, with a BM of 1.518 kcal/day we obtain a total energy expenditure, using the same PAL, of 2.125 kcal.

The Roza and Shizgal Equation: A Revision of the Harris–Benedict Equation

An initial revision of the Harris and Benedict equation led to the development of regression methods that lead to very similar results. In the equations presented by Roza and Shizgal we obtain the following expressions:

$$\text{For men BM (kcal/24 h)} = 88.36 + (13.39 \times \text{Weight}) + (4.79 \times \text{Height}) - (5.67 \times \text{Age}) \tag{4.8}$$

$$\text{For women, BM (kcal/24 h)} = 447.59 + (9.25 \times \text{Weight}) + (3.09 \times \text{Height}) - (4.33 \times \text{Age}) \tag{4.9}$$

Weight is expressed in kg, height in cm and age in years. With reference to the data used in Harris and Benedict's example, by applying this equation we obtain a BM of 1.694 kcal/day for men and of 1.506 kcal/day for women. To obtain the overall energy cost it is necessary to follow the same procedure used for the Harris–Benedict equation and calculate the daily PAL. With a PAL of 1.4 we obtain a total energy expenditure amounting to 2.372 kcal/day for men and 2.108 kcal/day for women. The difference consists in a small quantity of calories highlighting a close convergence between the two equations.

The Mifflin–St. Jeor Equation

The authors Mifflin and St. Jeor develop a new equation for calculating basal energy expenditure that gives a more accurate result than the original Harris–Benedict equation.[14] The study carried out led to the definition of the following regression equation:

$$\begin{aligned} \text{BM} = {} & 9.99 \times \text{Weight} + 6.25 \times \text{Height} - 4.92 \times \text{Age} \\ & + 166 \times \text{Sex (man, 1, woman, 1)} - 161 \end{aligned} \tag{4.10}$$

Weight is expressed in kg, height in centimetres and age in years.[15] As can be seen, the equation differs for males and females. To calculate total expenditure it is necessary to use the PAL following the procedure described for the previous equations. Using the parameters indicated in the Harris–Benedict equation you obtain a BM value of 1.650 kcal/day for men and 1.484 for women which corresponds, given a PAL of 1.4, to a total energy requirement, respectively of 2.310 kcal/day for men and 2.078 for women. The value is slightly lower than with the first equations analyzed. An important finding that this study points to is the close relationship between lean body mass, fat free mass (FFM) and energy expenditure. In 1989 Mifflin, develops the following equation which relates energy expenditure to an individual's lean body mass.

$$\text{MB} = 413 + 19.7 \times \text{FFM} \tag{4.11}$$

In the above equation the only independent variable is constituted by lean body mass and the calculation does not change according to sex, age or body weight. It goes without saying that in order to calculate FFM it is necessary to use specific instrumentation.

The Cunningham Equation

Changes in lifestyle and nutrition in industrialized countries progressively lead to changes in the methods used to calculate individual energy needs. Cunningham's research concentrates on the fact that weight is not always an accurate indicator of

[14]To be precise, in his original work, Mifflin focuses on the calculation of Resting Energy Expenditure (REE) which corresponds to the energy used by an individual at rest for 24 h and coincides, though not entirely, with BM.

[15]A simplification of the equation and the subdivision between men and women leads to the following equations which deliver results very different from those given by the original formula:

$$\begin{aligned} \text{BM (males)} &= (10 \times \text{Weight} + 6.25 \times \text{Height} - 5 \times \text{Age} - 5) \text{ andBM (females)} \\ &= (10 \times \text{Weight} + 6.25 \times \text{Height} - 5 \times \text{Age} - 161) \end{aligned}$$

.

the health of an individual because it does not consider the difference between lean mass, fat free mass (FFM) or lean body mass (LBM) and fat mass,[16] (FM). Each of them, in fact, is related to a different metabolism which has a crucial effect on individual energy expenditure. Cunningham formulates an equation to enhance the following:

$$\mathrm{BM} = 370 + (21.6 \times \mathrm{LBM}) \tag{4.12}$$

where LBM stands for lean body mass, measured in kilograms. After due study, Cunningham develops the following equation:

$$\mathrm{BM} = 500 + (22 \times \mathrm{LBM}) \tag{4.13}$$

This equation does not differentiate between males and females. LBM, corresponding to Fat Free Mass, is measured in kg, and is more closely related to energy expenditure. The calculation of total expenditure makes use of the PAL. Body composition in terms of distribution of lean and fat components does not vary from individual to individual and complex methods reported in the literature, such as plicometry, are used to calculate it, (Cunningham 1991; WHO 1995). In 1990, Cunningham publishes a further work in which he reviews the literature from 1980 to 1990 focusing on the correlation between lean mass and energy expenditure where detailed information about the application of the various equations can be found.

The Schofield Equation

Schofield produced predictive equations for both sexes for the following ages: 0–3, 3–10, 10–18, 18–30, 30–60 and >60 years, based on the observation of a large population sample. The results of his study, which formed the basis for the equations used in the FAO, WHO and UN document in 1985 entitled Energy and Protein Requirements[17] are reported in Table 4.4.

By applying the equations listed above an individual's basal metabolic rate can be calculated and the only independent variable in the equation is represented by body weight expressed in kg. By this we mean the actual body weight of an individual which should hopefully correspond or be as close as possible to ideal body weight (Henry 2005). To obtain total energy expenditure we use the same procedure as for Harris–Benedict in which we calculate the PAR, weighting them

[16]For further information about the difference between LBM and FFM, see Cunningham (1990).

[17]Schofield and other authors have reviewed the literature produced worldwide regarding the calculation of energy requirements and have developed new equations to calculate the basal metabolic rate to facilitate the Food and Agriculture Organization/World Health Organization/United Nations University joint expert consultation on energy and protein requirements. A meeting of experts was convened in Rome from 5 to 17 October 1981 for the purpose of reviewing energy and protein requirements.

Table 4.4 The Schofield equations for the calculation of basal metabolism according to age

Age (years)	Male (BM kcal/die)	Female (BM kcal/die)
<3	59.5P − 31	58.31P – 31.1
3–9	22.7P + 504	20.3P + 845
10–17	17.7P + 650	13.4P + 693
18–29	15.3P + 679	14.7P + 496
30–59	11.6P + 879	8.7P + 829
60–74	11.9P + 700	9.2P + 688
≥75	8.4P + 819	9.8P + 624

Source Schofield et al. (1985); Commission of the European Communities (1993)

throughout the day to get the PAL. Once we have obtained the physical activity level, this is multiplied by the basal metabolic rate to obtain total energy expenditure. With reference to the same data for men and women we will have a basal metabolism value of respectively 1.691 and 1.438 kcal/day. With a PAL equal to 1.4 we can calculate the daily total expenditure amounting to 2.367 kcal/day for men and 2.013 kcal/day for women. The values are in line with those obtained using the other equations cited above with only slight differences.

The Santoprete Equation

The methods adopted to calculate energy requirements discussed above, use the so-called *conservative* method to calculate the BM. This requires the individual's actual observed body weight to be inserted into the equation. In the following equations the *normative* method is used. This requires the use of weight and structural values considered to be optimal. Consequently, the *ideal* or *desirable* body weight will be needed, the calculation of which can be found in the final section of this chapter. The equations set out below present another peculiarity in that they take into consideration a series of values and translational coefficients to calculate the overall energy requirements rather than just the basal metabolism. Santoprete drew up the following equations, subdivided according to sex and age groups.

$$E \text{ (male) (kcal/day)} = (815 + \alpha m \times Pm) \times \beta \times \gamma m \tag{4.14}$$

$$E \text{ (female) (kcal/day)} = (580 + \alpha f \times Pf) \times \beta \times \gamma f \tag{4.15}$$

where:

- E is the individual's total energy expenditure;
- 815 and 580 are representative values of basal metabolism, obtained through observation of a large sample of the population;
- Pm and Pf represent ideal body weight, for men and women respectively;

Table 4.5 The values of coefficients α_m and α_f expressing the intensity of physical exertion

Physical activity	Reference values	
	Male	Female
Completely sedentary	22	23
Partially sedentary	24	26
Light	30	31.1
Moderate	36.6	35
Heavy	41	40
Very heavy	45	–

- αm αf express physical activity, or rather, intensity of exertion for men and women;
- β is a correction parameter for external temperature variations;
- γm γf represent correction coefficients with reference to the individual's age.

Moving on to analyze in more detail the various components of the equation, it is important to remember that ideal weight is that which can ensure the highest attainable standard of well-being in the individual. It can be calculated by applying appropriate equations or it can be taken directly from tables that take into account the individual's sex, age and physical build—tall and thin, short and stocky, average and so on.[18] The parameters αm and αf are directly proportional to energetic requirements in that increasing physical exertion increases energy expenditure. The value of the coefficients is reported in Table 4.5.

The β parameter expresses the variations in the external temperature that force the body to exert itself in order to adapt to maintain a constant temperature around 37 °C. With an external value of 10 °C, the β parameter will be equal to 1 and will undergo a reduction of 5 % for each increase of 10 °C. On the contrary, for every decrease in temperature of 10 °C the increase in the energy requirement will be 3 %. For example at a temperature of 20 °C the β parameter will have a value of 0.95 whereas at 0 °C it will be equal to 1.03. It is interesting to note that the decrease and increase are not proportional and that the former is higher than the latter demonstrating a lower energy requirement when the external temperature increases compared to a higher energy requirement in the case of a harsh climate. Finally, the coefficient γ corrects the energy requirement in view of the reduced energy required with advancing age. In fact, as can be seen from the analysis of Table 4.6, from the age of 30 onwards the value falls below the unit and gradually leads to a reduction in the value of total expenditure. To calculate energy

[18]Wrist circumference is an indicator of body build. In fact, we talk about someone who is tall and thin or of slight build when the wrist circumference is less than 14 cm for women and 16 cm for men. We talk of someone w-ho is of average build in the case of a wrist circumference between 14 and 18 cm for women and between 16 and 20 for a men. Finally, an individual is considered stocky or of heavy build with a wrist circumference greater than 18 cm for women and 20 cm for men.

Table 4.6 Coefficients γ_m and γ_f correcting for age

Age bands	Coefficients to be applied	
	Male (γ_m)	Female (γ_f)
From 15 to 19 years	1.13	1.04
From 20 to 29 years	1.00	1.00
From 30 to 39 years	0.97	0.97
From 40 to 49 years	0.94	0.94
From 50 to 59 years	0.865	0.865
From 60 to 69 years	0.79	0.79
Above 70 years	0.69	0.69

expenditure for children and adolescents under the age of 15, generally tables which refer to both sexes are used (EFSA 2013).[19]

For example, a 30 year-old man, with an ideal body weight of 70 kg, performing a light physical activity at an outside temperature of 20 °C, will have the following energy needs:

$$E(\text{kcal/day}) = (815 + 30 \times 70) \times 0.95 \times 0.97 = 2.686 \quad (4.16)$$

In the case of a woman of the same age, with an ideal weight of 70 kg, performing a light physical activity at a temperature of 20 °C the energy requirements are as follows:

$$E\,(\text{kcal/day}) = (580 + 31.1 \times 70) \times 0.95 \times 0.97 = 2.541 \quad (4.17)$$

This equation tends to overestimate the energy requirement by 10–20 % and so, to ensure a correct interpretation of the result, it is advisable to carry out a cross-check by applying of other equations.

The Institute of Medicine Equation (2005)

In 2002, a report was published on the evaluation of nutrient intake to ensure a correct nutrition both for single individuals and for the US and Canadian population as a whole. It is a product of the Food and Nutrition Board of the Institute of Medicine (IOM), working in cooperation with Canadian scientists. Specific equations were developed in order to calculate energy expenditure (Estimated Energy Requirement, EER), in an adult of a certain age, sex, weight and height, performing a certain physical activity. In the report, the evaluation of energy expenditure

[19]To have more precise data on the calculation of the energy needs of children and teenagers, related to the intensity of physical activity, please consult the website: http://www.efsa.europa.eu/it/efsajournal/doc/3005.pdf.

is set in relation to the intake of foods providing nutrients capable of maintaining a good state of health. The equations are as follows:

$$\text{EER for men aged 19 and older: (kcal/die)} = 662 - (9.53 \times \text{Age}) + \text{PA} \times \left[(15.91 \times \text{Weight}) + (539.6 \times \text{Height})\right] \quad (4.18)$$

$$\text{EER for women aged 19 and older: (kcal/die)} = 354 - (6.91 \times \text{Age}) + \text{PA} \times \left[(9.36 \times \text{Weight}) + (726 \times \text{Height})\right] \quad (4.19)$$

Age is expressed in years, height in metres and weight in kilograms. The latter must refer to desirable body weight and not the real weight. PA is a coefficient representing the intensity of physical activity (Physical Activity Level, PAL) and can be classified into four levels, sedentary or light activity lifestyles, low activity, active, very active. Sedentary derives from the Latin word *sedentarius*, from the present participle of the verb *sedere*, which means to sit. This includes any activity that has a low-level energy expenditure. Naturally, at rest, the body organs require a *minimum* amount of energy for vital functioning which is known as the basal metabolic rate (BMR). Each motion, action and gesture entails an additional energy cost. These people have occupations that do not demand much physical effort, they are not required to walk long distances, they generally use motor vehicles for transportation, they do not exercise or participate in sports regularly, and they spend most of their leisure time sitting or standing, with little body displacement (e.g. talking, reading, watching television, listening to the radio, using computers). Active or moderately active lifestyles are when people have occupations that are not strenuous in terms of energy demands, but involve more energy expenditure than that described for sedentary lifestyles. Alternatively, they can be people with sedentary occupations who regularly spend a certain amount of time in moderate to vigorous physical activities, either during the obligatory or the discretionary part of their daily routine. Finally, vigorous or vigorously active lifestyles are when people regularly engage in strenuous work or in strenuous leisure activities for several hours. The level of physical activity used in the equation and classified according to the intensity of the exertion is reported in Table 4.7.

If we apply the equation to a man and a woman each aged 30, weighing 70 kg, with a height of 1.75 m, who perform moderate activity, we obtain an energy

Table 4.7 Physical activity coefficients for men and women

	PA	
	Men	Women
If PAL is estimated to be $\geq 1.0 < 1.4$ (sedentary)	1.00	1.00
If PAL is estimated to be $\geq 1.4 < 1.6$ (low active)	1.11	1.12
If PAL is estimated to be $\geq 1.6 < 1.9$ (active)	1.25	1.27
If PAL is estimated to be $\geq 1.9 < 2.5$ (very active)	1.48	1.45

Source IOM (2005), p 157

Table 4.8 A comparison of the main equations for the calculation of an individual's energy requirements

	Energy requirements (kcal/day)	
	Male	Female
Harris–Benedict	2.381	2.125
Roza and Shizgal	2.372	2.108
Mifflin–St.Jeor	2.310	2.078
Schofield	2.367	2.013
Santoprete	2.619	2.541
IOM	2.660	2.303

requirement amounting to 2.660 kcal/day for the man and 2.303 kcal/day for the woman. In this example, there is a correspondence between the subject's real weight and his ideal body weight. The overall energy requirement is overestimated compared to the results obtained with equations that use the basal metabolic rate and are therefore more accurate. Summarizing the results obtained by applying the various equations we can extract some figures and make some observations (Table 4.8).

To conclude this analysis of the equations used for calculating energy requirements, it is important to remember that there is no perfect equation and an exact calculation can only be made using calorimetric methods. However, as the empirical equations are based on large samples of the population they have tolerable margins of error. We recommend the use of a combination of formulas to reduce possible discrepancies to a minimum. The value thus obtained is an excellent starting point to define daily food intake and create, within the range of kilocalories permitted to achieve an energy balance, the optimal diet (optimal intake).

Definition of Optimal Body Mass

The weight of an individual is a key indicator of health status, and over time, of any change in the body compartments. They indicate the continuation or not of a state of well-being.[20] For this reason, it is necessary for each individual to know his/her ideal or desirable body weight. The term comes from the statistician Louis I. Dublin (1882–1969) who during his studies realized that people of the same sex and height presented a very high range of weight variation and tried to classify them by dividing the observed population into three categories according to their body build: small, medium and large (Pay and Paloucek 2000). The average weight of each category was termed "ideal" and later "desirable" .It follows that

[20]Weight is only one of the anthropometric measurements commonly used to evaluate nutritional health. Indeed, build, circumference, body diameters and skinfold measurements may also be used.

weight, as an absolute value, does not have a significant meaning, rather it must be examined in relation to the height and the age of the individual. To calculate desirable weight different equations can be used, among which the most famous is definitely the Quetelet Index or BMI (Body Mass Index) developed by the homonymous scholar in 1832. Adolphe Quetelet (1769–1874) was a mathematician, astronomer and Belgian statistician who wanted to define a "normal" man in order to calculate the distribution around the norm. During observation Quetelet met many difficulties until he managed to identify the relationship between weight and height represented by the following equation:

$$\text{Quetelet Index} = P/h^2 \tag{4.20}$$

where P represents the weight expressed in kilograms and h the height of an individual in metres (Quetelet 1832).

For an adult, regardless of sex, desirable body weight corresponds to a body mass index (BMI) between 18.5 and 25 kg/m^2 (WHO 1995). The average value is represented by 22 kg/m^2 and in the absence of real values can be considered the reference value from which to obtain, given the height, the desirable body weight. The assessment of BMI values is reported in Table 4.9.

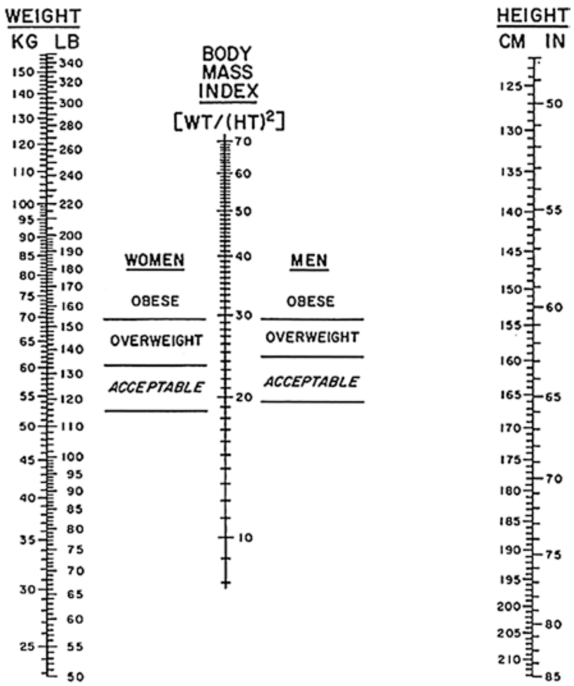
Body mass index is used extensively to identify the desirable weight of an individual but it presents a series of limitations. Firstly, as is apparent from the equation itself, it has a higher correlation with body weight and a lower correlation with height. The former is expressed in kg the latter in metres. Therefore, it is not very reliable for heights below 1.50 m and above 1.80 m. Secondly, it is unable to differentiate an overweight condition linked to the presence of lean body mass, as in the case of athletes or bodybuilders, because it does not distinguish lean body mass from fat body mass (Willett et al. 1999). Furthermore, it is not applicable to children below 18 years of age and finally, it is to be used with caution with the elderly or pregnant women. The equation's margin of error is around 3–6 %. Body mass index enables us to draw a normogram (Fig. 4.1). This is a graphical representation which highlights the relationship between weight and height, both for men and women. The normogram is very simple to use; it is sufficient to join the values corresponding to an individual's height on the left, and weight on the right, and find their meeting point in the middle where the corresponding status (normal, underweight, overweight or obese) will be indicated.

Table 4.9 Interpretation BMI values

BMI <16.00	Indicate grade 3 thinness
BMI 16.0–16.99	Indicate grade 2 thinness
BMI 17.0–18.49	Indicate grade 1 thinness
BMI 18.5–24.99	Is the normal range for an individual
BMI 25.0–29.99	Indicate grade 1 overweight
BMI 30–39.99	Indicate grade 2 overweight
BMI ≥40.00	Indicate grade 3 overweight

Source WHO (1995), p. 452

Fig. 4.1 Exemple of a Normogram



To calculate desirable or ideal body weight it is possible to use other equations including the best known which are Broca's (Park et al. 2013) and Lorentz's (Bouillanne 2005), both related only to height:

$$\text{IBW (Broca), for men} = h - 100 \pm 10\,\% \tag{4.21}$$

$$\text{IBW (Broca), for women} = h - 104 \pm 10\,\% \tag{4.22}$$

$$\text{IBW (Lorentz), for men} = h - 100 - \{[h - 150]/4\} \tag{4.23}$$

$$\text{IBW (Lorentz), for women} = h - 100 - \{[h - 150]/2\} \tag{4.24}$$

where h represents height expressed in centimetres. For example, a man with a height of 170 cm will have an ideal weight calculated with Broca between a minimum of 63 kg and a maximum of 77 kg, while a woman of the same height will obtain a desirable weight between 59 and 73 kg. With Lorentz values will be respectively 65 and 60 kg, significantly lower.

Many other equations have been developed by various authors and among them we remember those of Hamwi, Devine, Robinson and Miller summarized in the Table 4.10.

In 2005, a simple equation was introduced for estimating ideal body weight (IBW) in kilograms for both men and women (Lemmens et al. 2005). The equation is the following:

Table 4.10 The most common equations for calculating desirable body weight

Reference	Equation
Hamwi (1964)	For men 48.0 kg + 2.7 kg/each inch over 5 ft[a] For women 45.5 kg + 2.2 kg/each inch over 5 ft
Devine (1974)	For men 50.0 kg + 2.3 kg/each inch over 5 ft For women 45.5 kg + 2.3 kg/each inch over 5 ft
Robinson et al. (1983)	For men 52 kg + 1.9 kg/each inch over 5 ft For women 49 kg + 1.7 kg/each inch over 5 ft
Miller et al. (1983)	For men 56.2 kg + 1.41 kg/each inch over 5 ft For women 53.1 kg + 1.36 kg/each inch over 5 ft

[a]For a correct application of the equations it is important to remember that a *foot* corresponds to 30.48 cm whereas an *inch* is equivalent to 2.54 cm. Consequently, 5 ft are 152.4 cm

$$\text{IBW} = 22 \times H^2 \tag{4.25}$$

where H is equal to patient height in metres (Harry et al. 2005).

The parameter 22 is derived from the average value of the normal range of ideal body mass index obtained by applying Quetelet's equation.

Conclusion

The evaluation of an individual's energy requirements can be estimated with the help of specific equations that take into account or give appropriate weighting to factors of influence such as weight, sex, age, physical activity and environmental temperature. The most accurate equations appear to be based on the calculation of the basal metabolic rate to which subsequently the proportion of energy related to physical activity is added and calculated as a multiple of the resting metabolic rate itself. The margins of error of the equations analyzed are minimal. On the contrary, the equations that calculate energy requirement values directly tend to overestimate significantly. For this reason, it is preferable to calculate an average of the values obtained by applying different equations. Although the calculation of energy requirement using non-calorimetric methods cannot correspond exactly to the real energy needs of each individual, it is nevertheless important to use it as a starting point for the creation of an optimal diet in order to ensure, together with the maintenance of desirable weight, a state of health and well-being and to avoid many of the diseases related to over or under-nutrition.

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Chapter 5
Nutrition Fundamentals

Abstract In order to survive, the organism needs a series of substances that fulfill functions of an energetic regulatory nature, plastic or protective and balancing. They are subdivided into macro and micronutrients, on the basis of the quantity required by the organism. Glucides, protides and lipids belong to the first category, while vitamins and mineral salts to the second, with the addition of water, a fundamental element for every form of life. At the basis of proper nutrition is the choice of foodstuffs to which the optimal composition of these elements corresponds, in order to satisfy all of the organism's needs and allow its proper functioning with time. Our organism elaborates numerous substances every day, even if requirements are differentiated per quantity. Furthermore, some substances must be introduced in diet since the organism is not able to synthesize them, and naturally, special attention will have to be given to these so as to avoid any form of shortage. In the present chapter, macro and micronutrients are analyzed briefly in order to pinpoint the optimal relationship of daily intake in the light of each single need. Finally, a brief examination of water and ethyl alcohol will be carried out.

The Macronutrients (Glucides, Protides and Lipids)

The macronutrients glucides, protides and lipids are substances which provide the necessary energy to the organism for it to survive, besides performing other important functions. They are defined as macro because high quantities are taken in compared to micronutrients, and in fact for the former, the unit of measure is the gram, while for the latter, the milligram or microgram. To complete nutrition there is also water, an indispensable element to life and ethyl alcohol, making up numerous categories of drinks and which is able to provide energy, but differently to the other substances. It is not a necessary element for mankind's survival. Energy provided by macronutrients and ethyl alcohol is referred to in Table 5.1.

As deduced by the values provided, they contribute in equal proportion to the energetic balance, while higher values are recorded for ethyl alcohol and

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Table 5.1 Energy value of some food constituents

Constituent	Kcal/g	KJ/g
Carbohydrates	4	17
Protein	4	17
Lipid	9	37
Ethyl Alcohol	7	29

Source Greenfield and Southgate (2003), p.146

lipids. Theoretically, it would be possible to fill energetic needs even by taking in only one macronutrient. For example, an individual with an energetic need of 2.000 kcal could take in 500 g carbohydrates or proteins, or rather, 222 g lipids, or finally 286 g alcohol, in order to satisfy energy needs. Nothing is more wrong. If the quantitative of energy decreases, so does the balancing of substances on the basis of functional needs. As far as the contribution of the various substances to our organism is concerned, we must distinguish between the concept of **necessity** and **essentiality.** A substance that the organism uses electively for carrying out of some functions, but in the absence of nutrition intake, is defined as necessary. It is able to synthesize it thanks to special metabolic cycles. A substance required for the organism vital functions which the human body is unable to synthesize in any way, is defined as essential. Therefore, it will have to be taken in with diet subsequently so as to avoid pathologies related to deficiency. In order to illustrate classification, functions carried out by the organism, and individual needs, the categories of macronutrients will be dealt with in the course of our report.

Glucides, from the Greek "*glykús*" meaning sweet[1] are made up of ternary carbon compounds, hydrogen and oxygen—with empirical formula $C_n(H_2O)_2$—to which is added poli-oxo-aldehydes or poli-oxo-ketones. They form the nutrition basis of all the globe's population groups since starch became the main source of energy in our diet with the arrival of agriculture and cereal grain cultivation. Glucides can be classified on the basis of chemical structure, *degree of polymerization* and *availability*. On a chemical level, glucides are made up of compounds of different molecular weight, and are distinguished into *monosaccharides,* considered as elementary units in that they cannot be demolished for hydrolysis like glucose, fructose and galactose, *disaccharides,* if they contain two elementary sugars like saccharose, lactose and maltose, *oligosaccharides* containing from 3 to 10 like maltodextrins, and finally *polysaccharides* containing over 10 monosaccharides, such as starch, considered a reserve polysaccharide, glycogen, a glucose reserve and fiber, structural polysaccharides. On the basis of the degree of polymerization, we distinguish glucides in the two large categories, *simple* and *complex*. The first,

[1]Glucides are also called carbohydrates, or carbon hydrates, usually subdivided in simple or complex, sugars or saccharides, from the Latin " *saccharum* " meaning sugar, generally subdivided into mono or polysaccharides. All these names derive from the fact that the prime glucides pinpointed were sweet and tasty, which in actual fact belongs to the category of simple carbohydrates only.

commonly said sugars,[2] are the monosaccharides, disaccharides and oligosaccharides, generally of a solid structure, white, crystal clear, sweet and easily soluble in water. Polysaccharides belong to the category of complex glucides, dry and *vice-versa*, that lose their sweet taste. On the basis of individual availability, the classification pinpoints two typologies of glucides: *available*, or rather, directly used for an energetic scope by the cellular metabolism, and *unavailable,* for glucides which the organism is not able to use directly since they are not digestible, absorbable nor metabolizable. Among the simple available carbohydrates there are sugars, commonly contained in foodstuffs, like monosaccharides, glucose and fructose, and disaccharides like saccharose, maltose and lactose. They can be used as such, or found in foods and drinks with the scope of enhancing taste. Among the simple unavailable carbohydrates found in foodstuffs, we wish to recall dry monosaccharides, xylose and among disaccharides and oligosaccharides, lactucarium, raffinose and stachyose. Other substances totally or partially unavailable are made up of polyhydric alcohol, also known as sugars or polyols. Among these we recall xylitol, maltitol and sorbitol. The first two are particularly important and always diffused in products like sweets and chewing gums for their anticariogenic power. In fact, their non-constant digestibility transforms into bacterial plaque in the mouth, and sugars in acid substances can attack the tooth's microcrystalline structure, causing tooth decay. Furthermore, they have a reduced energetic strength, equal to around 2,4 kcal/g, but it is advisable not to exceed a daily intake of 50 mg/kg of body weight, so as to avoid possible side effects such as the laxative one. Among the complex carbohydrates there is starch that is available, and glycogen, while non-starchy polysaccharides, commonly known as alimentary fibers are not. Nutrition fibers comprise numerous substances that have a close nutritive or energetic value since they can contribute in very scarce quantities. However, they carry out a very important role for regulating the organism's physiological functions. They are subdivided into water-soluble and non-water-soluble, if they present the ability to absorb water or not. Pectins are water-soluble, as well as chewing gums, mucilages and galactomannans. During the digestive process, they slow down gastric emptying and allow to reduce the sensation of being hungry, and the absorption of nutrients. Non-water-soluble fibers on the other hand, increase intestinal motility, reducing contact times of waste substances that come into contact with the intestinal walls, and also reducing absorption of possible toxic elements. Belonging to this category is cellulose, hemicellulose and lignin. A further classification of alimentary fibers has been proposed at international level to put into relationship the absorption of these fibers with effects on the organism, and subsequently determine the optimal quantities to be inserted in diet. The definition is based on work carried out by the Panel on the Definition of Dietary Fiber and subsequent modifications, and is the following (IOM 2005, p. 340):

- **dietary fiber** consists of non-digestible carbohydrates and lignin that are intrinsic and intact in plants;

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[2]The term "sugar" is traditionally used to describe mono e disaccharides (FAO/WHO, 1998).

Table 5.2 The main available and unavailable alimentary glucides

Class	Subgroup and degree of polymerization	Component
Simple available glucides	Monosaccharides (1) Disaccharides (2) Oligosaccharides (3-9)	Glucose, galactose, fructose Saccharose, lactose, maltose Maltodextrins
Simple unavailable glucides	Disaccharides (2) Polyhydric alcohol (1-2) Oligosacchcarides (3-2)	Lactucarium Maltitol, mannitol, xylitol and sorbitol Raffinose, stachyose, verbascose
Available complex glucides	Polysaccharides (> 9)	Starch, glycogen
Unavailable complex glucides	Polysaccharides (> 9)	Cellulose, hemicellullose, pectin, galactomannans, glucomannans, inulin

Source our elaboration on Costantini et al. (2011), p. 289

- **functional fiber** consists of isolated, non-digestible carbohydrates that are beneficial to physiological effects in humans;
- **total fiber** is the sum of dietary and functional fiber.[3]

In the report by the Institute of Medicine (2001), intrinsic and extrinsic sugars are also mentioned, and the terms originate from the United Kingdom's Department of Health. Intrinsic sugars are defined as sugars that are present within the cell walls of plants (i.e. naturally occurring), while extrinsic sugars are those that are typically added to foods. The terms were developed to help consumers differentiate sugars inherent to foods, from sugars that do not naturally occur in foods. In Table 5.2 glucides are listed and classified per typology.

Glucides make up the preponderant part of every nutrition diet and can be introduced in the form of sugars, whose main source is made up of saccharose, in different forms and purification such as white, brown or raw honey, maize syrups and malt, non-alcoholic beverages, products that mostly bring added sugars, and finally fruit and derivatives from where natural sugars are obtained. Instead, the main sources of complex carbohydrates (starches) are cereals such as wheat, maize or rather rice, potatoes and derivative products such as flour, pasta, bread and crackers. Not all sugars have the same sweetening strength, and among the natural ones there is fructose in first place with 1, 3, considered a reference value for saccharose equal to 1. Also widely diffused are artificial sweeteners, in consideration of sweetening strength that overbearingly outclasses the natural ones (Table 5.3). However, consumption of sweeteners presents a series of criticisms (Tarabella and Burchi 2011).

Glucides make up 1 % of body weight and carry out firstly, an energetic function, and secondly, a structural function, in that they make up part of the cellular

[3]For a detailed indication of the classification of fibers and the effects of the single units on the human organism, reference IOM (2001) e IOM 2002–2005.

Table 5.3 Sweetening strength of main natural and artificial sugars

Natural sugars	Sweetening strength	Artificial sugars	Sweetening strength
Saccharose	1	Cyclamate	30–80
Fructose	1,3	Acesulfame K	160–250
Glucose	0,7	Aspartame	130–250
Lactose	0,3	Saccharin	300–500
Xylitol	0,9	Sucralose	400–600
Maltitol	0,75	Thaumatin	2.000–2.500
Sorbitol	0,7	Alitame	1.800–2.000
Mannitol	0,5	–	–
Maltodextrin	0,1	–	–
Starch	0	–	–

structure. As far as carbohydrates are concerned, we speak about necessity, because in case of failed nutrition through diet, the organism is able to synthesize them thanks to the decomposition of proteins and fats, in particular, triglycerides.[4] However, it is good to recall that the organism uses glucose as elective source of energy to feed the cells of the nervous system, and the erythrocytes, and therefore bioavailability of glucose is essential.[5] The **recommended daily intake** of glucides is between 45 and 65 % of the complex energetic intake. If we consider an average need of 2.000 kcal/die, glucides correspond to 900–1.300 kcal equal to 225–325 g. According to IOM data, the average intake of carbohydrates is approximately 220–330 g/die for men and 180–230 g/die for women (IOM, 2002). For some scholars, it could be considered equal to around 4 g per kg desirable body weight. In any case, the energetic amount is to be preferred, which derives from foodstuffs containing starches, while the energetic amount that derives from foodstuffs containing refined sugars should not exceed 10–12 % of daily energy. In a diet based on 2.000 kcal/die it corresponds to around 200–240 kcal or rather, 50 g. Finally, as far as fibers are concerned, the optimal intake relationship for adults between 31 and 50 is 38 g/die of total fiber for men, and 25 g/die total fiber for women.

Lipids, from the greek "*lípos*" meaning fat, are ternary compounds of hydrogen carbon and oxygen, but differently to the other macronutrients (glucids and protids), they contain a higher quantity of hydrogen in the molecule which justifies an energetic value twice as high (9 kcal/g against the 4 kcal/g). They are soluble in water but only in appropriate organic solvents (ether, chloroform and benzol) and from their decomposition (hydrolysis) there derives an acid fat and an alcohol.

[4]However, it is good to recall that in the energetic use of glucides, potentially dangerous metabolic byproducts are left, such as urea in the case of proteins, or chetonic bodies in the case of fats.

[5]In order to satisfy energy needs of the nervous system and erythrocytes, an adult subject needs between 10 and 140 g/die of glucose (Cahill et al. 1968).

Generally, **triglycerides** are comprised in the category of lipids that make up the main component of the amount of fats provided with the diet (98 %), **phospholipids** and **sterols**. From the point of view of the lipid composition, we can distinguish them into *simple*, if formed uniquely by carbon, hydrogen and oxygen, generally present in foodstuffs and adipose tissue of individuals, and *complexes*, if they also contain nitrogen and phosphorous in their molecules, constituents of cellular membranes and plasma. From a nutrition point of view, we can distinguish them into deposit and structural lipids. The former are formed mainly by triglycerides and make up an important reserve of energy and an indispensable source of nutrients. For a man weighing 70 kg, the quantity of fat should be equal to around 11 kg, corresponding to an energetic reserve of 99.000 kcal. Surely, fats make up the ideal means to accumulate energy, in that if the same energy should be accumulated in the form of glycogen, we would have an increase in body weight equal to 100 kg, as we would have the same increase in energetic accumulation with lean or muscular mass.[6] Structural are also phospholipids and sterols, from where the organism needs smaller quantities to be included in diet, and the typology of fatty acids contained in phospholipids is similar to the triglycerides, described further on.[7] Finally, from a nutrition point of view, lipids can be subdivided into visible, if identifiable and separable in the edible parts of a foodstuff, and invisible, if on the contrary they make up the chemical-structural part, and therefore do not seem separable by the foodstuff itself.

The most variable part of the molecule in lipids is made up of fatty acids that are classified in the following categories[8]:

- saturated fatty acids;
- monounsaturated fatty acids;
- polyunsaturated fatty acids (n-6 and n-3 fatty acids).

Fatty acids do not present double links which characterize the polyunsaturated, while a single double link is present in monounsaturated. Table 5.4 sums up the typologies of fatty acids present in foodstuffs.

Fatty acids make up the most important of lipids since linoleic acid (n-6) and **α-**linoleic (n-3) are not synthesizable by the organism, and therefore for these components we speak about essentiality, while the other lipid constituents can be provided with the decomposition of other substances. In particular, from the acid **α-**linoleic there derive two fats, eicosapentaenoic (EPA) and docosahexaenoic (DHA) important for the prevention of cardiovascular illnesses, and for the proper

[6]The elevated value is due to the fact that the energetic density of the glycogen-water pool and lean tissues is around 1 kcal/g seeing that every gram of glycogen or lean tissue binds 3 g of water.

[7]As far as cholesterol is concerned, in actual fact need is not scientifically proven in that the organism not only needs a small quantity, but it is able to produce it endogenously.

[8]It is necessary to state precisely that monounsaturated fatty acids and polyunsaturated are present in the form of *cis* and on completion of the fatty acid category, we also add *trans*, whose classification depends on the isomeric structure of the molecule.

Table 5.4 Typologies of saturated fatty acids, unsaturated and polysaturated

Saturated Fatty Acid	Caprylic acid Caproic acid Lauric acid Myristic acid Palmitic acid Stearic acid	Monounsaturated Fatty Acid	Elicosenoic acid Erucic Myristoleic acid Oleic acid Palmitoleic acid Vaccenic acid
Poliunsaturated fatty acids n-3	α-Linoleic acid Docosahexaenoic acid Docosapentaenoic acid Eicosapentaenoic acid	Poliunsaturated fattu acids n-6	Adrenic acid Arachidonic acid Dihomo-γ-linolenic acid Docosapentaenoic acid γ-Linolenic acid Linoleic acid

Source IOM 2002–2005

functioning of the central nervous system and retina. In a proper diet, the complete elimination of lipids is therefore unthinkable, since it is necessary to guarantee at least the intake of essential fatty acids that are found in foodstuffs such as olive oil, sunflower oil, maize oil and soya. A deficiency in the supply of these two substances determines a reduction of organism's ability to grow, a limitation of the reproductive ability, scaly rash and an increase in consumption of water not accompanied by urinary excretion (Jones et al. 1999). Lipids make up between 17 and 21 % of body weight and in general, fulfilling multiple functions. The first is represented by the **energetic**, actually making up a reserve of energy which can be used at any time the need arises. For example, in case of sport activity, the organism starts liberating substances able to decompose lipids before using the reserve of glycogen, make up a long chain of glucose, and immediate assimilation.

The second function carried out by lipids is the **structural**, they are in fact fundamental constituents of cellular membranes and nervous sheaths, the third is a **regulatory** type, in that they are precursors of hormones, biliary acids, carotenoids and form the regulation of body temperature. The fourth and last function is **transport,** since they allow liposoluble vitamins to be channeled (A, D, E and K) that are absorbed only in the presence of fats.

Foodstuffs that are source of lipids can be of animal or vegetable origin. The former, commonly known as fats, have a high fusion point, and they present a solid structure at room temperature for the high presence of saturated fats. Lipids, of vegetable origin, commonly known as oils, present a low fusion point, and they are liquid at room temperature for the high presence of unsaturated fats. In fact, some animal fats are liquid at room temperature, with due exceptions such as fish oil, among which cod liver oil, and some vegetable fats present a solid structure, such as coconut oil and palm oil, due to the high number of saturated fatty acids present in the chemical molecule. The principal food sources that contribute to fats intake are butter, margarine, vegetable oils, visible fat on meat and poultry products, whole milk, egg yolks, nuts and baked foods like cookies, doughnuts and cakes. The recommended daily intake of glucides is between 20 and 35 % global energy. If we consider an individual with an average need of 2.000 kcal/die, the total lipids correspond to 400–700 kcal equal to 44–78 g daily. For some scholars, needs are equal to around 0.5–1 g per kg ideal body weight. A further nutrition indication foresees subdividing consumption according to the following indications:

- 10–15 g for saturated;
- 25–40 g for monounsaturates;
- 10–15 g for polysaturates.

Naturally, these indications are associated to predilection in the consumption of products containing essential fatty acids, amongst which they must be provided in an amount of at least 17 g/die for men, and 12 g/die for women, in that they cling onto linoleic acid, and respectively, 1.6 g/die and 1.1 g/die for men and women, with reference to linoleic acid. The quantity indicated by IOM (2005) for cholesterol is between 250–325 mg/die for men and 180–205 mg/die for women, which is a very modest consumption.

In the last few years, the consumption of fat in nutrition has progressively increased, in consideration of the increased ability to enhance taste of foods, especially if associated to the use of sugars. On the contrary, it is desirable to reduce consumption thereof so as to allow respecting doses prescribed by nutritionists and avoid all pathologies correlated to an excessive consumption of fatty substances.

Protids, from the greek "*prôtos*" meaning first,[9] they are ternary compounds of carbon, hydrogen and oxygen, to which we add nitrogen, an indispensable element for the proteinic formation, and in some cases, also sulphur, phosphorous and metals, such as copper, iron and zinc. They are the most complex and variable compared to other sources of energy like carbohydrates and lipids, and the match between dietary supply and human protein needs is vital to support health and wellbeing of human populations. Proteins are macromolecules made up of long chains of amino acids which make up the subunits linked to each other according to a specific sequence for each protein, that is genetically predetermined and defines its specific function.[10] Amino acids that enter in the formation of the peptidic chain are 20 for all living beings[11] and 9 of these must be introduced in diet as preformed because the organism is not able to synthesize them even if in the proteic synthesis all 20 amino acids must be present contemporarily, and therefore are equally indispensable. From a nutritional point of view, it follows that amino

[9]Protids are considered the first elements and owe their name to the fact that only with the synthesis of proteins do we have the birth of life on earth.

[10]It is opportune to recall that the various amino acids take on diverse roles according to the functions of the proteinic molecule from which they are made up, and therefore the evaluation of the biological functions of the single amino acid seems extremely complex.

[11]Amino acids present in the organism are a few hundred and they belong to the L configuration, but only 20 of these enter to form part of the proteinic constitution, at least by an aminic group (NH) and a carboxylic group (CO).

Table 5.5 Nutritional classification of amino acids

Indispensable	Dispensable	Conditionally indispensable
Histidine	Alanine	Arginine
Isoleucine	Aspartic acid	Cysteine*
Leucine	Asparagine	Glutamine
Lysine	Glutamic acid	Glycine
Methionine	Serine	Proline
Phenylalanine		Tyrosine*
Threonine		
Tryptophan		
Valine		

Source Laidlaw and Kopple (1987), p. 593, Costantini et al. (2011), p. 260* these amino acids are considered semi-essential in that cysteine derives from methionine and tyrosine from phenylalanine

acids can be classified into two large groups: indispensable (essential), semi-indispensable or semi-essential and dispensable (non-essential), the latter further divided into truly dispensable and conditionally dispensable. Amino acids are indispensable because the organism is in no way able to synthesize by other amino acids present therein, or other complex nitrogenous metabolites, while they are indispensable if the organism is able to produce them autonomously. Amino acids that derive from two essential amino acids are semi-essential, and therefore intake with diet decreases related needs. Finally, amino acids with relevant biological functions as such are conditionally indispensable, or conditionally essential, or for products to which they give rise to, although deriving from the decomposition of other amino acids, in certain physiological or physio-pathological conditions may not be so at the required speed and therefore can become essential (Laidlaw and Kopple 1987). More simply, conditionally indispensable is defined as requiring a dietary source when endogenous synthesis cannot meet metabolic need. The nutritional classification of the amino acids is indicated in Table 5.5.[12]

The origin of the protein can be endogenic, or alimentary, or esogenic due to recovery and use of internal secretions. Therefore, if we take in around 100 g of useful proteins with diet, it will not be equal to 100 but rather 170 g to be digested and absorbed. The efficiency of the process used is very high, equal to around 95 %, considering that the deficiency of takings is around only 10 g. Differently to other macronutrients, proteins cannot be accumulated[13] and are subject to a constant demolition process and synthesis that takes on the name of protein turnover. Studied in the 30 s by Shoenheimer and Rittenberg, it has given a remarkable impulse to scientific studies on nutrition. In particular, the authors pointed out how

[12]Amino acids can be classified even from a functional point of view based on the polarity of radicale R linked to carbon α, and pinpoints many amino acids amongst which aliphatic, aromatic, hydroxy and carboxylic, or metabolic, on the basis of origin of its formation.

[13]Glucides, if taken in excess, form the glycogen chain, real reserve of energy, or rather, they are transformed into fats. The latter, if introduced with diet in higher quantities to one's needs, are stored as adipose deposit, to be used when necessary.

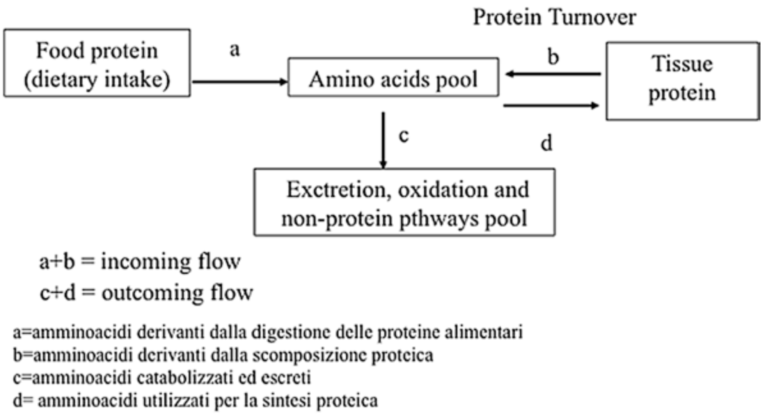

Fig. 5.1 Diagram of the proteinic metabolism

the proteinic turnover concerned all proteins, not only some, be they heterogeneous, or rather, characterized by diverse speeds,[14] of an intracellular character, that is that the synthesis and demolition occurred on the inside of the cell, even if not necessarily in the same one, and finally, that it be regulated both in synthesis and degradation. The formation of proteins depends ultimately on the speed of synthesis and degradation of the amino acids, and the increase of proteinic mass can be examined also in relation with variation of speeds—increase in speed of synthesis, or reduction of speed of degradation, or both—it follows that the global result can remain unchanged, even as a result of contemporary and opposing modifications in different sites to the organism. As is deduced by the analysis of Fig. 5.1, there exists a flow of proteins that reach the organism through nutrition (a). The decomposition of proteins will form the pool of amino acids also fed by the endogenous degradation of bodily proteins (b). Flow a + b ultimately represents the source of proteins. From the pool of amino acids we will have an outflow determined by the process of synthesis (d) and pool of excretion or oxidation (c).

The objective of a proper diet is to provide an adequate quantity of amino acids aimed at guaranteeing the proteinic balance. It is measured in terms of nitrogen (making up around 16 % of the proteins)[15] and we get it from the difference between nitrogen, introduced daily through foods, and nitrogen eliminated daily. There are actually three possibilities:

1. $a + b = c + d$;
2. $a + d > b + c$
3. $b + c > a + d$

[14]Proteins live on average 80 days, considered in their totality, but can live only 24 h, as in the case of intestinal epithelium cells, few days as plasma proteins, up to 100 days for haemoglobin, and also a few hundred days for muscle protein and collagen.

[15]To go from nitrogen to protein source, simply multiply N by factor 6.25 seeing that it makes up 16 % in bodily composition.

In the first case, the organism finds itself in perfect equilibrium, and it is the optimal maintenance condition of an adult's state of health. In the second case, there is a condition of muscle mass growth, that could depend on an intense sport activity, or recovery conditions following a period of inactivity or illness. In the third hypothesis, there is the case of a reduction in proteinic mass for insufficient nutrition intake, and if prolonged, could hinder an individual's state of health. From a nutritional point of view, proteins come from the vegetable kingdom—cereals, legumes and seeds—and animal—meats, fish, eggs, milk and derivatives—and it is very important to consider quality. From a nutritional point of view, proteins can be classified into two large categories: **complete** and **incomplete**. Proteins containing all 9 essential amino acids are defined as complete, while those lacking even one of these are incomplete. However, in order to assess the proteinic quality level, it is necessary to consider that the presence of all the essential amino acids is a necessary condition, but not sufficient to maintain the proteinic balance, in fact, it is necessary for them to be present in the right proportion, useful to the proteinic construction. An example can help clarify what has been stated above. In order to build up a protein that we will call A, if it is necessary for all nine essential amino acids to be present in the proportion indicated in the first line of Table 5.6 (naturally besides all the other 11 non-essential amino acids) and that the amino acid values referred to in the second line were to be taken with diet, even in the presence of all 9 amino acids, it would not be possible to build Protein A. In the second example, it is possible to build a single protein A, and finally, as last hypothesis, we recognize the possibility of building a good three proteinic units A. On the basis of this indication, proteins can be further classified into proteins **with a high biological value,** if they contain all the essential amino acids in the right proportion that is useful to the proteinic formation, **with a low biological value**, if they contain all the essential amino acids but not in the right proportion, and finally, **no biological value,** if lacking even one essential amino acid. Products with a higher biological value are generally made up of those of animal origin, while those of a vegetable origin are mainly incomplete and less absorbable, given the lower level of digestibility.

Table 5.6 An example of proteins with a low, high and nil biological value

	Essential amino acids									Number of built proteins
Proteina A	1	2	3	4	5	6	7	8	9	
Necessary units to build a unit	3	2	5	6	3	4	2	1	7	1
Intake of aminoacids (e.g. 1)	6	8	10	24	16	12	1	6	21	It is not possible to build protein A
Intake aminoacids (e.g. 2)	6	8	10	24	16	12	2	6	21	It is possible to build protein
Intake of aminoacids (es. 3)	6	8	10	24	16	12	6	6	21	It is possible to build 3 protein As

If the content of a single indispensable amino acid in the diet is less than individual's requirement, then it will limit the utilization of other amino acids, and thus prevent normal rates of protein synthesis even when the total nitrogen intake level is adequate. In the example reported in Table 5.6, protein A is limited in its formation by the presence of amino acid 7, which gets its name from **limiting factor,** since it makes the proteinic formation impossible, and also the use of other essential amino acids present in the foodstuff. The biological quality of the proteins depends on the presence or not of the essential amino acids (i**ntrinsic quality**), but also by the interaction of the protein with the human organism (**extrinsic quality**).[16] In order to assess the extrinsic quality, it is necessary to introduce the concept of *digestibility* and *bioavailability*. For digestibility, we mean the percentage of protein taken in that is absorbed by the organism and varies from individual to individual, while the concept of bioavailability also recomprises the capacity of use by the organism of the amino acids contained in the single protein.[17] The term "bioavailability" encompasses three properties of foods that can alter the proportion of an amino acid that can be utilized. These elements being:

- *Digestibility*, which describes the net absorption of an amino acid;
- *Chemical integrity*, which describes the proportion of the amino acid, that if absorbed, is in a utilizable form;
- *Freedom* from interference in metabolism resulting from the presence in food of substances that limit utilization of the amino acid.

Of these, the greatest source of variation in bioavailability is, in most cases, digestibility (FAO 2013). In order to assess the food sources in proteinic terms, the chemical score used is aimed at assessing the contents of a single essential amino acid contained in a protein, and the corresponding amino acid in a reference pattern is considered optimal, generally egg or milk. This method is very important to define the quality of foods, but it does not allow expressing its digestibility. The assessment of protein quality is very important to defining the messages to be written on nutrition labels and claims, with the purpose of protecting the consumer. In particular, according to international indications, to qualify for the nutrition claim: "source" for protein, a food must meet the following criteria:

- 10 % of nutrient reference value (NRV) per 100 g (solids);
- 5 % of NRV per 100 ml (liquids);
- or 5 % of NRV per 100 kcal (12 % of NRV per 1 MJ);
- or 10 % of NRV per serving.

[16]Since 1989 the Protein Digestibility Corrected Amino Acid Score (PDCAAS) method for evaluating protein quality has been used widely. Recently, a new has been recommended for application in practice.

[17]Some proteins, such as keratin, are highly insoluble in water, and hence are resistant to digestion, while highly glycosylated proteins, such as the intestinal mucins, are resistant to attack by the proteolytic enzymes of the intestine.

To qualify for: “high” iron or protein, the food must contain twice the values of “source” (FAO 2013, p. 14). Proteins carry out a class of very high functions in an organism of a structural and functional type. From a structural point of view, the *plastic* or *histogenetic* functions are up to the proteins, appointed for building cellular structures, while from a functional point of view, they carry out a *protective* role, as constituents of antibodies or growth factors of intestinal flora, *regulator* in that they form biological catalysts, enzymes and hormones, and finally *transport* of nutrients and other substances in the blood, nervous impulses and muscular contraction. They make up around 15–18 % of the human body, and food requirements is equal to around 0.80 g per day per kg ideal body weight, for both men and women, corresponding to between 56 g and 46 g, respectively, with reference to an average weight of 70 kg for men and 58 kg for women. Considered an average energetic food requirement of 2.000 kcal, the corresponding amount to be attributed to proteins is equal to around 11 % for men and 9 % for women.

The Micronutrients (Vitamins and Mineral Salts)

Micronutrients are substances that the human body needs in minor quantity. Vitamins and mineral salts belong to this category. Vitamins were discovered only in the early twentieth century, and in particular, thanks to Casimir Funk, a Polish chemist who moved to the United States, his merit was to have studied and researched the topic in depth. Starting from Christiaan Eijkman’s observation, Nobel prize for medicine, who had realized that administering rice husk allowed treatment of beriberi, a typical illness among populations accustomed to consuming husked rice. In 1911, Funk succeeded in identifying the responsible substance, thus called, and to theorize the etiology of the illness caused by deficiency. In the conviction that similar substances contained an aminic group, he defined it the “aminos of vita” from where the name vitamin derives, and is still believed nowadays. Furthermore, in relation to the illness in question, the said vitamin was called B, to begin a route that would have led to indicating every subsequent vitamin discovery with a progressive alphabetical letter. In actual fact, with the evolution of scientific studies, we realized that not all vitamins contain an aminic group but they present a molecular and chemical structure, and characteristics which are highly heterogenous, and therefore it has not been possible to name same with an alphabetical letter. The discovery of vitamins has taken time, and has been a source of difficulties and errors. For example, a vitamin C deficiency causes a definitive illness called scurvy, that affected especially sailors who stayed at sea for long periods of time, and who did not have the possibility to consume fresh foods, rich in vitamin C. Considering that the illness manifested itself with unhealthy states affecting support tissues (bones, cartilages and connective tissue), with shaking and jerky movements, from where the present name scorbutic derives, the sailors were kept in quarantine far from the coast, thereby causing further progressive worsening of their conditions. Thanks to James Lind, surgeon in the British Royal navy, subminestering lemon juice to those sailors affected by this helped to observe a progressive improvement of the pathological conditions of the illness, until they managed to get back to perfect normality. Finally, another interesting case regards the diffusion of pellagra in Italy around 1730, due to a deficiency of vitamin B3 or PP. Likewise defined as “illness from the rose” since it manifested itself with a diffused dermatitis, derived by poor diet based solely on the consumption of maize. To aggravate the understanding of an unhealthy state, there was an analogous situation among mesoamerican populations, who although they consume a large quantity, almost exclusively maize, they were not affected by the same illness. The reason was linked to the fact that the *tortillas* consumed by the mesoamericans were previously treated with alkalis, able to separate the chemical link of the vitaminic precursor making it bioavailable. All of this has contributed to making the path of understanding difficult for the functions of vitamins.

Nowadays 13 substances that are classified in two large groups are comprised in this denomination, on the basis of the degree of solubility in water or fats respectively: hydrosolubles and liposolubles.[18] The hydrosoluble vitamins are those from the B complex and vitamin C, and their characteristic is not to give problems of accumulation if taken in excess, since they are easily eliminated through urine thanks to their solubility in biological liquids. The list of hydrosoluble vitamins with the indication of the principle functions absorbed in an organism, as well as the source of nutrition and daily food requirement are resumed in Table 5.7. The liposoluble vitamins are those within groups A, D, E and K, and differently from the previous ones, they can accumulate in an organism giving rise to phenomena of toxicity, and their consumption is made easier by the presence of fats in the foodstuffs that contains them, or in the diet consumed. The liposoluble vitamins, with the indication of main functions absorbed in an organism, and source of nutrition and daily food requirement, are resumed in Table 5.8.

Vitamins are essential substances and must be introduced in pre-format to avoid states of hypovitaminosis that regress rapidly following administering of the deficient vitamin or food that contains it. A food that contains them all does not exist, therefore nutrition must be sufficiently varied so as to allow a complete intake. They are not used for an energetic or plastic scope, but they carry out a r**egulating** function, some biochemical reactions of the organism, and **protective**, in that they are true and proper antioxidants. In some cases, we speak about provitamins, that are real and proper precursors of usable vitaminic form by the organism, and to become such they must be activated by internal factors, such as, for example bioavailability of ergosterol, precursor of vitamin D2 which is activated thanks to the action of ultraviolet light which comes from the sun or internal factors, such as, for example the transformation of carotene into vitamin A. Only these two

[18]A few scholars have subdivided vitamins on the basis of their origin, into animal and vegetable, or rather, on the basis of the sensitivity to heat in thermolabile and thermoresistent. In actual fact, given the heterogenous structure and behaviour, the only classification accredited at International level and useful from a nutritional point of view, is that on the basis of solubility.

Table 5.7 Hydrosoluble vitamins: food sources, properties and daily needs

Vitamin	Principal functions	Nutrition source	Daily food requirement*
B1 o thiamine or aneurin	It makes up an important coenzyme in the metaboliim of glucids, promotes and favours processes of trophism in certain tissues, especially those of the central nervous and peripheral system	Wholegrain wheat flour, type "0 " and "00", whole rice, chicken and pork meat, cow's milk, legumes, peas	1.2 mg/die
B2 or lactoflavin	Participates in the formation of coenzymes that intervene in the reactions of oxide, reduction of cellular respiratory processes	Diffused in foodstuffs, it is present in yeast, fresh vegetables (spinach, cabbage, broccoli, asparagus). Mostly contained in milk and derivatives, albumen, liver and kidney	1.3–1.8 mg/die
B3 or PP or niacin	It is essential in coenzymes that intervene especially in the metabolic passages of sugars and biological functions linked. They have to do with the normal tissue integrity, in particular, for skin, gastroenteric tract and nervous system	Present in foodstuffs of animal origin especially liver, kidney and heart. It is also found in whole wheat flour	6.6 mg/die per every 1000 kcal taken with a minimum of 19 mg for men and 14 for women
B5 or Pantothenic acid	Constituent of the coenzyme A, the essential molecule in many metabolic reactions of different nutrients, hormones and regulating substances of the nervous system. It favours functionality of cells in various tissues, in particular, the epithelial ones.	It is diffused in vegetable and meat food products (from the Greek "pàntothi" meaning anywhere. Rich in this is liver, egg yolk, yeast, cereals and legumes	5–10 mg/die
B6 or Adermina or pyridoxine	Constituent of enzymes of the metabolism of glucides and lipids. It also intervenes in the formation of fundamental substances of the cerebral metabolism such as dopamine and serotonin	It is found in the useful information of products having an animal origin	1.4 mg/die for men and 1.1 mg/die for women

(continued)

Table 5.7 (continued)

Vitamin	Principal functions	Nutrition source	Daily food requirement*
B12 or cobalamina	It participates in the formation of the necessary substances to the synthesis of nucleic acids, reactions of the metabolism of proteins, lipids and glucids, and the formation of red corpuscles	Products of animal origin	2 μg/die
Folic acid	Participates in the synthesis of nucleic acids, the formation of red corpuscles and differentiation of the neural tube at embryonic level	It is found diffusely in leafy vegetables, liver, legumes, scarce in fruit, milk and meats	0.2 mg/die
Biotina o vitamina H	Important coenzyme in the metabolsim of fats, proteins and sugars, and it is important for the proper functioning of the nervous system.	Present in all animal and vegetable tissues, particularly abundant in meats, poultry, egg yolk and liver	30–100 μg/die
C	Participates in the biosynthesis of collagen, noradrenalin, carnitine, catabolism of tyrosine, biosynthesis of biliary acids, activation of folic acid, biosynthesis of steroidal hormones, and metabolsim of iron. It carries out an important antioxidant function	Abundant in fresh vegetables and citrus fruit	60 mg/die

It is difficult to establish the daily food requirements of vitamins with precision in that it depends on multiple factors and nutrition in its totality, since some substances can constitute inhibitors, or in other cases favour proteinic bioavailability. Therefore, the values referred in the table are to be considered indicative

Table 5.8 Liposoluble vitamins: food sources, properties and daily food requirements

Vitamins	Main functions	Nutrition source	Daily food requirements
A	Vitamin A is indispensable for the mechanism of vision and for cellular differentiation, therefore it is necessary for growth, reproduction and integrity of the immune system	Preformed presence only in foods of animal origin, in those of vegetable origin they are in the form of provitaminic	700 RE* for men and 600 RE for women
D	Its principal functions are : stimulation of absorption of calcium and phosphorous at intestinal level, regulation in synergy with the parathyroid hormone, plasmatic levels of calcium, maintenance of a suitable mineralization of the skeleton	Present in appreciable quantity only in a few foods of animal origin such as cod liver oil, cod fillet of herring and salmon, whole milk, butter and a few derivatives	Exposure to sunlight is sufficient to satisfy the organism's daily food requirements of vitamin D
E	High antioxidant properties: it comes from oxidation of polyunsaturated fatty acids (PUFA)	Mainly contained in foods of vegetable origin	4 mg/die for men and 3 mg/die for women
K	Important in the coagulation of blood (involved in the formation of active prothrombin)	Widely distributed in foods, it is present in appreciable quantities in green leaf vegetables	1 μg per kg of desirable body weight

The level of daily intake of vitamin A is expressed in terms of retinol equivalent (RE). 1 RE = 1μg retinol = 6μg β-carotene = 12μg other carotenoids forms of provitamins are known, A and D, even if we often refer to a group of products commercially speaking, only in the scope of promoting same, even if not supported by scientific evidence. Vitamins must be taken in small quantities, as indicated in Tables 5.6 and 5.7, and a diet which is sufficiently varied permits filling every individual's needs fully. However, the industrialization of food production could jeopardize the quantity of vitamins present in foods. An example is refining of cereals, washing vegetable by soaking, chopping or crushing (especially for vitamins A and D), long preservation of fruit, vegetables and meats, preparation of precooked foods, conserved in the refrigerator and then warmed up (especially for vitamins B6, C, PP and E), and finally, cooking and exposure to light of the foodstuff (vitamin C, A and folic acid). Degradation of vitamins can reach as much as 50 % but it is never total. Mineral salts are inorganic substances that do not contribute to energetic intake, but they carry out important **structural functions** like cellular and tissue constituents, and are **regulators** of the hydrosaline balance, muscular contractility and functioning of the nervous system.

The concept of essentiality applies to them as the organism is unable to produce them autonomously, and therefore, they must be taken through diet or water reintegration. The concept of bioavailability is very important, meaning the quantity of nutrient absorbed and made available to the organism after being converted in active physiological form. It depends on **intrinsic factors** such as species, genetic set, age, sex, physiological state, intestinal flora for absorption, state of health and extrinsic factors, such as chemical form of the mineral, solubility in liquids and presence of antagonists. The combination of diet intake affects the bioavailability of mineral salts. They are subdivided into **macroelements**, if present in a proportion equal to gram per kilogram of body weight, or **microelements**, if present in lower proportion to milligram per kg of body weight. Belonging to the first category, we have sodium, potassium, calcium, phosphorous and magnesium, and to the second category, iron, zinc, copper, manganese, molybdenum, iodine, fluorine, chromium, selenium and cobalt. Many of the mineral salts carry out functions that are still unknown, but there have been phenomena of intoxication for an excessive food intake that have been recorded.

In Table 5.9 the main mineral salts are indicated, function carried out, food source and recommended level of daily food intake.

Water and Some Considerations About Ethylic Alcohol

Man is made of 60–65 % of water, which is essential to life. It performs many functions as a solvent for many chemical and metabolic reactions, as a regulator of the cell volume and body temperature, it allows the transport of nutrients and the elimination of waste, and it is the source of many minerals. Water is essential to the human body because nutrition is not sufficient to satisfy daily requirements. The body does not tolerate variations of water content higher than 7 % and it can survive only 2–3 days in the absence of water supply, while thanks to water, it is

Table 5.9 The main mineral salts, functions carried out, food source and daily food requirements

Macroelements
Sodium regulates osmotic pressure, volume of extracellular fluids, basic acid balance, blood pressure (intake around 3.5 g/die) Source: table salt, stock cubes, preserved meat and fish, bread)
Potassium: nervous impulse transmission, muscular contractibility, regulating of blood pressure (intake around 3 g/die) Source: All foods, especially fruit, vegetables and fresh meats)
Calcium: structure of bone tissue, activator of enzymes, haemocoagulation) (intake around 800 mg/die) Source: milk and cheese, mollusks and crustaceans, legumes and dried fruit, artichokes, thistle, endives and spinach
Phosphorous: structure of bone tissue and in cellular membranes, constituent of nucleic acids, regulator of basic acid balance (intake around 1400 mg/die) Source: milk and cheese, egg yolk. cereal seeds, legumes
Magnesium: structural bone tissue, duplication of DNA, activator of enzymes (intake around 250 mg/die) Source: legumes, whole-wheat cereals, dried fruit, bananas
Microelements
Iron: presents itself in hemic form and enters the constitution of haemoglobin, ioglobin and hemo and non-hemo proteinic enzymes present in certain enzymes, transportation forms (transferrin) and reserve (ferritin and hemosiderin). Intake of around 10 mg for men and 18 mg for women Source: Heme forms are found especially in products of animal origin and it is absorbed in proportion equal to 25 %, in the non-heme form it is found in the vegetable Kingdom, and it is absorbed for around 2–10 %
Fluorine: participates in the formation and maintenance of bones and teeth (daily intake between 1.5 and 4.0 mg/die) Source: taken daily with drinkable water, it is contained in almost all foods

Table 5.10 Disorders caused by dehydration

% loss of body water	Symptoms*
1–2	Thirst, fatigue, weakness, loss of appetite
3–4	Alteration of physical strength, dry mouth, skin redness, impatience, apathy
5–6	Difficulty concentrating, headache, irritability, drowsiness, impaired regulating of body temperature, increased respiration
7–12	Dizziness, muscle spasms, delirium, exhaustion, coma, death

*The severity of symptoms depends on physical activity performed by the subject, level of training and environmental conditions of temperature and humidity

able to survive using the stocks of glycogen and fats for a much longer period of time. The effects of water scarcity are shown in Table 5.10.

Water is mainly contained in muscles (75 %), and only 10 % in adipose tissue. To ensure performance of all functions that compete through water resources, the organism must have it in sufficient quantity. Water sources can be of two types;

- Exogenous, such as foods and drinks;
- Endogenous, those coming from the metabolism.

With regard to exogenous sources, not all foods contain the same amount of water, and it goes from a minimum of 0 % for some products such as oil and sugar, to values that exceed 80 %, as in the case of fresh fruit, vegetables, and milk. Most of the water required by the body comes from exogenous sources, and generally 500–900 ml derives from food, while 800 to 1500 ml is form drinks.[19] With regard to endogenous sources, the organism can produce approximately 300 ml /day of water thanks to metabolic processes. In the oxidation process, carbohydrates produce 0.6 g of water per gram, protein 0.4 g, while lipids 1.07 g, in view of the higher hydrogen content. For example, a 70 kg man with an energy requirement of 2000 kcal daily divided into 15 % of proteins, 60 % carbohydrates and 25 % lipids will get about 270 ml of water from the complete oxidation of nutrients. It is important for the body to maintain the water balance over time; it means that the inputs and outputs are equivalent. The need for water varies from individual to individual, and it is influenced by body composition, feeding, external temperature, losses related to muscular activity. Therefore, the daily requirement is estimated at 1 ml /kcal. Hence, in a diet of 1500 kcal, the daily water requirement is equal to 1500 ml. Water as food must possess a number of characteristics, such as drinking water, mineralization, non-toxicity, pleasantness of taste, which are regulated by Directive 2009/54/EC of the European Parliament and Council of 18 June 2009, on the exploitation and marketing of natural mineral waters. The directive also classifies the various types of water as reported in Table 5.11, by assigning the respective trade name. Each EU Member State will have to authorize the marketing of the waters, which are indicated in the appropriate register in Europe. Among the many, those most marketed are the ones with a salt content comprised between 500 and 1500 mg/l. Many waters have met the consumer's acceptance, promoting a low level of sodium. Actually, the contribution of drinking water to the daily sodium intake is less than 10 % overall. Far more important, there are values of nitrates and nitrites that would be desirable if they were close to zero.

Ethyl alcohol is not a nutrient and is treated briefly in the present study to describe nutritional effects. Alcohol consumption has spread throughout the world. In 2010, with reference to the population over 15 years old, 6.2 litres of pure alcohol was consumed per capita year, corresponding to 13.5 g of pure alcohol daily. Alcohol consumption causes addiction to the effects generated on the central nervous system. Over time, a high consumption of alcohol can seriously affect health (WHO 2014). Worldwide diffusion of alcohol consumption, is shown in

[19]Not all drinks are good substitutes for water. For example caffeine and alcohol act as diuretics, causing a loss of body fluids.

Table 5.11 Classification of main waters according to Directive 2009/54/EC and denominations allowed for commercialization

Indications	Criteria
Low mineral content	The content of mineral salts, calculated as a fixed residue, not greater than 500 mg/l
Very low mineral content	The content of mineral salts, calculated as a fixed residue, not greater than 50 mg/l
Rich in mineral salts	The content of mineral salts, calculated as a fixed residue, greater than 500 mg/l
Contains bicarbonate	Bicarbonate content is above 600 mg/l
Contains sulphate	The content of sulphates is above 200 mg/l
Contains chloride	The chloride content is above 200 mg/l
Contains calcium	The calcium content is more than 150 mg/l
Contains magnesium	The magnesium content is greater than 50 mg/l
Contains fluoride	The fluorine content is higher than 1 mg /l
Contains iron	The content of divalent iron is greater than 1 mg/l
Contains sodium	The sodium content is above 200 mg/l

Source Directive 2009/54/EC, Annex III, p. 55

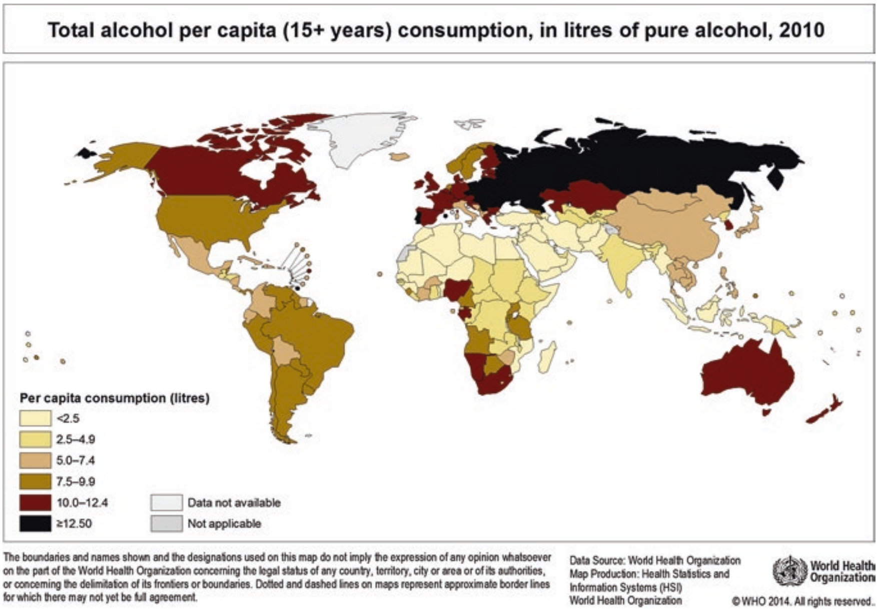

Fig. 5.2 Worldwide alcohol total consumption per capita

Fig. 5.2. Moreover, in recent years, alcohol consumption has spread even among the youngest generation, and in some cases it is associated with risky consumption behaviour, as the so-called "binge drinking". The latter consists in drinking alcoholic beverages in a limited period of time (WHO and European Commission

2012, p. 140), for example, 5–6 drinks on a single occasion, and this behaviour is often used as a “gateway drug” that is like a drug bridge for the consumption of stronger narcotics.

Alcoholic drinks are marketed with the indication of the alcohol content in % or in volume. An alcohol content of 12 % expresses the amount of ethyl alcohol in ml, shown in 100 ml of beverage. With the right proportion, we can transform the alcohol content in grams of alcohol ingested, and in kcal introduced in the body. For example, if an individual consumes a glass of wine (125 ml) with 12 % alcohol content, we will have a quantity of alcohol equal to 15 ml. Since the specific weight of the alcohol is 0.793 compared to the weight of the water, we obtain a value given in grams of 15 ml * 0.793, equal to 11.89 g. Whereas alcohol provides about 7 calories per gram, the total calories ingested will be 83.23. Once ingested, the alcohol is absorbed directly from the gastrointestinal tract because it is highly diffusible in tissues and body fluids and requires no digestion. Moreover, 80 % of the alcohol ingested, after being absorbed, is metabolized by only one organ, the liver. From a nutritional standpoint, alcohol causes many effects and interactions. First, alcohol provides “empty calories”. The latter, which are not accompanied with any nutritional principle, increase daily requirement, and they are quickly turned into fat. In addition, alcohol inhibits the process of synthesis of glucose and demolition of glycogen, as well as the assimilation of certain nutrients, particularly minerals and vitamins, with a worsening of nutritional value of the diet. Alcohol determines strong interference even with the central nervous system (cns). Reactions vary from subject to subject according to consumption, in relation to blood glucose values which depend on the total quantity of alcohol consumed, the concentration of alcohol in beverages, the time taken for the ingestion, intake on an empty stomach or full, the time between intake of food and alcohol, the type of power and speed of biotransformation and elimination of alcohol, partly linked to the gene pool. The alcoholic peak, which is the maximum concentration of alcohol in blood, is reached within 30–45 min on an empty stomach, and after 60–90 min on a full stomach. A detailed description of the effects of alcohol on the central nervous system is reported in Table 5.12.

As can be seen from the analysis in Table 5.12, the conditions of the individual in the case of alcohol intake change gradually up to compromising the perception of themselves and their abilities, generally overvalued, response to external stimuli, capabilities to guide—tendency to move towards the center line of the road and delay in risk perception—and motor coordination. All together, these factors are sufficient to deter driving in a drunken state. Drinks marketed in the world can be divided into three main groups depending on whether they obtained from one of the following processes:

- Distillation (spirits);
- Mixing or maceration (spirits);
- Fermentation (wines and beers).

The spirits are obtained by distilling fermented mash of fruit or grain alcohol to confer particular organoleptic characteristics. In particular, they are subject to

Table 5.12 Effects of alcohol consumption on the Central Nervous System

Blood alcohol content g/l	Effects
0.2–0.4	Mild euphoria, mild non-motor coordination and abnormal reflexes, mild reduction of judgment, tending to overestimate their own abilities and underestimation of risks, impaired perception and processing of sensory stimuli
0.5	Aggravation of the effects on the cns, tendency to drive in a risky, reduction of side vision (problems in the perception of traffic signs)
0.6–1.0	Drunkenness and confusion in speech, slowed reaction times, obvious difficulties in controlling motor coordination
1.1–3.0	Mental confusion, emotional instability, memory impairment, disorientation, ataxia, dysarthria, nystagmus, impaired vision
3.1–5.0	Severe drunkenness to coma: hypothermia, convulsions, hypotension, anaesthesia, respiratory depression until death

Source INRAN (2003), p. 63

ageing and the alcohol content varies from 40 to 60 %. This category includes brandy, aged in oak barrels, cognac, from the region bearing the same name, grappa, from the distillation of lees and marc, rum, molasses from sugar cane, whiskey distilled from barley and oats, vodka from wheat, rye and potatoes, slivovitz, plums, apples and calvados gin fruit, cereals and juniper berries. The liquors are made up of water, alcohol, sugar, with the addition of dyes and various aromas. The value of alcohol varies between 25–50 % and can even reach 70 % by volume. The wine is made from the fermentation of grape must and has an alcohol content that launches 10 to 13 %, while beer is derived from the fermentation of barley malt roasted by adding hops with an alcohol content of between 3 and 8 %. In conclusion, the alcohol is not considered essential for the organism, while making energy. Small amounts of wine or beer to be consumed with meals can also be beneficial because they stimulate digestion and help gastric emptying.

Conclusion

Foods deliver several substances to the body, which perform complex functions and are linked by functional and biochemical reactions, in part still unknown. Therefore, the individual experiences many difficulties in composing the optimal diet. Moreover, a strong aggressiveness of media messages from the food industry, which pushes the consumption of ever more elaborate foods with a number of considerably higher ingredients than in the past, is added to the lack of information. We need only think of the categories of functional products, enriched, nutraceuticals that offer distinctive elements more and more related to nutrition, and the effects of food on the body. In this chapter, the principles of nutrition (macro and micronutrients), water and ethanol have been analyzed in a very simplified manner so as to highlight what the body needs on a preferential basis and cannot be ousted by any diet (fatty acids and essential amino acids, minerals, vitamins and water), and what the body can do without it (for example ethyl alcohol or artificial sugars). It is hoped that a better understanding of the amazing machine that is the human body, can help in choosing foods for a daily diet including all useful substances, able to maintain optimum functionality over time.

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Chapter 6
The Evolution of Nutrition Information

Abstract The use of labelling helps to reduce information asymmetries between producers and customers. Indeed, it supports consumers in the process of detecting and evaluating qualitative product features, with particular regard to intrinsic or indirect features such as flavour, which cannot be assessed before purchasing or consumption. The utility of this information in product choices varies according to consumer mood at the time of purchasing, but it is also affected by subjective processes, habits and motivations. Moreover, it is also important to understand how consumers perceive and interpret the information indicated on labels. In the context of nutrition labelling, given its relevance to consumer diet composition, worldwide legislators have introduced specific formats on nutrition labelling with time, to support a correct understanding of nutrition information by consumers. Following the presentation on the evolution of nutrition labelling with EU regulations and other formats applied in the USA, as well as those used in other main countries, the chapter discusses both resolved issues and issues that still exist in the present system of nutrition labelling.

An Overview on Nutrition Labelling

Nutrition information systems help to reduce information asymmetries between producers and customers because they are the main source of nutrition information at the disposal of consumers. The several forms of information disclosed on a product range from nutrition labelling or facts label to daily reference values on the back of the food package, as well as health claims and disclaimers (Hieke and Wilczynski 2012) that appear on the front of the pack (Grunert et al. 2010). Nutrition information systems and related information may effectively support consumers in making healthier food choices (Baltas 2001), if correctly understood by consumers. Consumer comprehension of nutrition information indicated on food products is important because it makes consumers aware of food choices, given that such choices may affect diet composition and nutrition balance. However, it seems that the level of

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consumer comprehension of nutrition information on products differs according to the format of presentation (Jones and Richardson 2007). To this regard, nutrition labelling—or the facts table—is the most complete system of nutrition information to consumers because it basically indicates the amount of energy delivered (calories) and nutrients, and may also contain some information about micronutrients. In this way, nutrition labelling should drive the consumer's food choices from the vast ranges of products on supermarket shelves because it also provides information about intrinsic quality, as well as foodstuff value in comparison to price, which is the value attributed by the producer. The consumer has to recognize the right product for their diet easily and understand the food value rapidly. To this purpose, worldwide legislators have adopted specific rules regarding nutrition labelling in order to both support and protect consumers in their choice of food, while ensuring free movement within the food market. Such rules have also been changed with time as a consequence of emerging consumer needs and new food features or properties introduced by producers. For instance, the first consequence of the changes on the side of both demand and offer was the introduction of compulsory nutrition labelling for most foodstuffs. In the United States of America (hereinafter the USA), between 1972 and 1994, nutrition labelling was mandatory only for enriched or fortified products, or for products that made some type of nutrition-related claim on the label, but producers could label their products as they wished. In 1994, the FDA implemented the Nutrition Labelling and Education Act of 1990 (NLEA) fully, which required mandatory nutrition labelling for most food products, in order to contain increasing obesity among the US population. Regarding Europe, the European Parliament and Council have been issuing laws concerning information provided on foodstuffs since 1979. As a matter of fact, all labels in the pre-packaged foodstuffs marketed at Community level must list ingredients as stated in Directive 2000/13/EC (European Parliament and Council 2000), amended in Directive 2007/68/EC (European Commission 2007) and by Regulation 415/2009/EC (European Commission 2009). Directive 90/496/EEC (European Council 1990) states that nutrition labelling is also compulsory "where a nutrition claim appears in labelling, in presentation or advertising[1]" as confirmed by Regulation 1924/2006/EC (European Parliament and Council 2006). It is noteworthy that Directives 2000/13/EC and 90/496/EEC have been merged into Regulation 1169/2011/EC (European Parliament and Council 2011), which states that nutrition declaration is mandatory, an extended version of nutrition labelling provided by Directive 90/496/EEC, for most foodstuffs. This latter Regulation has been applied since December 2014. Therefore, the process of mandatory nutrition labelling in Europe was very long—over 30 years—and the European legislators will implement provisions similar to those adopted in the USA with a delay of over 20 years. In addition to the issues related to compulsory nutrition labelling, the content of this label varies greatly from country to country, namely the nutrient list and presentation may change according to specific cultural perspectives, or local nutritive needs, which

[1]Art. 2, c. 2, Directive 90/496/EEC.

may depend on the geographic position of the country, for instance. No doubt, these differences may pose some issues concerning needs for both information and protection of the global consumer, and also, in terms of harmonization of food market rules in order to face worldwide competition, with fewer and fewer frontiers.

The Evolution of Nutrition Labelling in Europe

Nutrition labelling was ruled in Europe in 1990 for the first time, with Directive n. 496. This norm defined the scope and criteria of applying nutrition labelling, as well as specific cases in which such a label was mandatory. Moreover, Directive 90/496/EEC also contained rules regarding the content of nutrition labelling and ways of presentation. According to this Directive, nutrition labelling was optional for most food products, but mandatory for products with a nutrition claim, that is "any representation and any advertising message stating, suggesting or implying that a foodstuff has particular nutrition properties due to the energy (calorific value)".[2] In this case, the product had to declare the energy and nutrients list with the related amount.[3] Actually, Directive No. 496 did not establish specific rules regarding content, that is, the message delivered by nutrition claims, although it provided for the latter to comply with the general principle which prohibits misleading information (European Commission 2001). In particular, this Directive pointed out two ways of presenting nutrition information in nutrition labelling, as described in Table 6.1.

Nutrition labelling indicating group B is more complete, and is compulsory for products with nutrition claims on sugars, fatty acids, sodium and fibre.[4] According to Directive 90/496/EEC, nutrition information on groups A and B had to be shown in table scheme, similar to those reported in Table 6.1, in which the orders of information and name are compulsory: it means that similar terms and synonyms are not allowed. In addition to nutrition fundamentals of groups A and B, nutrition labelling could reveal information about the quantity of the following components: starch; polyols; monounsaturated fat; polyunsaturated fat; cholesterol; vitamins and mineral salts as shown in Fig. 6.1, if they were present in the product with a quantity equal to 15 %—at least—of the recommended daily allowance calculated on 100 g or 100 ml.[5] Mandatory points about the content of nutrition labelling were (1) indicating only numeric values[6]; (2) referring to 100 g or 100 ml of product (in addition, nutrition values per portion or per serving can also

[2]Art. 1, c. 4, point (b), Directive 90/496/EEC.

[3]Art. 6 Directive 90/496/ECC.

[4]Art. 4, c. 2, Directive 90/496/EEC.

[5]Art. 4, c. 3, Directive 90/496/EEC.

[6]Art. 6, c. 1, Directive 90/496/EEC.

Table 6.1 Standards for nutrition labelling, Dir. 90/496/EEC

Group A	Per 100 g/per 100 ml/per serving/per portion	Group B	Per 100 g/per 100 ml/per serving/per portion
Energy value	kcal and kJ	Energy value	kcal and kJ
Protein	g	Protein	g
Carbohydrate	g	Carbohydrate	g
Fat (cholesterol)	g (mg)	Fat (cholesterol)	g (mg)
		Saturates	g
		Fibre	g
		Sodium	g

Source Our elaboration of Directive 90/496/EEC

Fig. 6.1 Vitamins and minerals which may be declared and their recommended daily allowances (RDAs). *Source* Annex 1, Directive 90/496/EEC

Vitamin A µg 800	Vitamin B12 µg 1
Vitamin D µg 5	Biotin mg 0,15
Vitamin E mg 10	Pantothenic acid mg 6
Vitamin C mg 60	Calcium mg 800
Thiamin mg 1,4	Phosphorus mg 800
Riboflavin mg 1,6	Iron mg 14
Niacin mg 18	Magnesium mg 300
Vitamin B6 mg2	Zinc mg 15
Folacin µg 200	Iodine µg 150

be shown)[7]; indicating the energy in kcal or in kJ[8]; quantifying protein by multiplying the total nitrogen by the factor 6.25[9]; and showing the quantity of saturated fatty acids when the amount of polyunsaturated fat, monounsaturated fat, and/or cholesterol is reported.[10]

The accuracy of the declared amounts, which are average values, must be confirmed by analysis, to be carried out by the manufacturer on the food, or on each ingredient, or by generally accepted official data.[11] However, starting from the second half of the 90s, the European legislator made a thorough review on the

[7]Art. 6, c. 2, Directive 90/496/EEC.

[8]According to conversion factors reported in the art. 5, c. 1, Directive 90/496/EEC.

[9]Art. 1, c. 4c, Directive 90/496/EEC.

[10]Art. 4, c. 4 s paragraph, Directive 90/496/EEC.

[11]Art. 6, c. 8, Directive 90/496/EEC.

Table 6.2 Consumer opinions and observations from food companies on nutrition labelling according to Directive 90/496/EEC

Consumer difficulties, due to	Food company concerns, due to
Format of nutrition labelling	Prescriptive nature of the legislation
Lack of understanding of nutrition fundamentals	Effects of packaging design
Position of nutrition information on the labelling	Restricted scope of the company-level innovation
Font size of information shown on the nutrition labelling	Cost associated to any changes in labelling legislation

Source Authors' elaboration from the European Commission (2008)

nutrition labelling legislation in order to give consumers clear nutrition information based on evidence and concrete elements, and able to respond effectively to growing consumer attention on the relationship between diet and health. In 1994, the EU Council laid down detailed norms for nutrition labelling of spreadable fat with Regulation 2991/94/EC (European Council 1994). However, the needs to simplify the framework on the one hand, and strengthen the efficacy of nutrition information made on food on the other, has led the EU legislator to merge the two most important labelling rules—Directive 2000/13/EC and Directive 90/496/EEC into a unique norm concerning food product information to consumers, namely Regulation (EU) 2011/1169. The legislative process of this rule was launched by a stakeholder consultation, brought about with a survey that was carried out between 2003 and 2007. This consultation involved a lot of people representing different categories of stakeholders. In addition, an open discussion on the Internet also took place between March and June 2006. The overall results highlighted that stakeholders were not satisfied with the regulation of nutrition labelling planned by the 1990 Directive and there were diverging opinions about how to improve it. Some of these observations are summarized in Table 6.2. In particular, it became necessary to investigate the position on nutrition labelling on pre-packaged products specifically, nutrition fundamentals to be necessarily included on the labelling, the simplification of nutrition labelling and the readability of the information. Therefore, the revision of the legislation on nutrition labelling's specific target was to fix the above-mentioned criticality, while considering the needs arising from production and distribution. For that purpose, the new regulatory system was planned with the aim of increasing nutrition information on food products, thanks to a wider use and clarity of content. This goal should be achieved with the harmonization of rules across the Member States in order to allow free competition among companies. The result is represented by a synergic fusion of the various regulations existing prior to the revision, so as to "increase clarity and consistency of Community rules" (European Commission 2008). The Regulation mentioned specifically takes care of the discipline on nutrition labelling in articles 29 to 35 included. These articles present a substantial continuity with the modality of content presentation, that is, in table form,[12] however, extending the field of application to all food, except for food supplements, as in the previous Directive, regulated by Directive 2002/46/EC (European Parliament and Council 2002), and mineral water, regulated by Directive 2009/54/EC (European Parliament and Council 2009b), except the disposition of Directive 2009/39/EC (European Parliament and Council 2009a) related to the so-called diet foods, intended for a specific diet.[13]

Other new features include, first, the name itself of such labelling, which becomes nutritional declaration, and subsequently, its minimum mandatory contents, represented by (a) the energetic value; and (b) amount of fat, saturated fatty acids, carbohydrate, sugars, protein and salt. Close to the nutrition declaration, a statement may also be included where appropriate, indicating that the salt content is exclusively due to naturally contained sodium.[14] However, in case that the energetic value or the amount of nutrition fundamentals of a product is negligible, the information related to these elements can be replaced by a statement like "contains negligible amounts of …" positioned in close proximity to the nutrition declaration when present.[15] Moreover, in addition to the above-mentioned mandatory content, the amounts of one or more of the following fundamentals can be included: (a) monounsaturated fatty acids; (b) polyunsaturated fatty acids; (c) polyols; (d) starch; (e) fibre; and (f) minerals or vitamins, for which the indications in Article 4 of Directive 90/496/EEC remain substantially unchanged, excluding the case of beverages, for which the threshold is no longer 15 %, but 7.5 %. However, the list of minerals and vitamins has been extended, as shown in Fig. 6.2. Therefore, compared to that which is established in Directive 496 of 1990, it is no longer possible to indicate the cholesterol in food, and the sodium content has been replaced with the amount of salt.[16] It has to be highlighted that the nutrition declaration can reveal only the energy value, or the latter with the amount of fat, saturated fatty acids, sugar and salt, in the case of non-pre-packaged foods.[17] Moreover, in case of beverages with an alcoholic content higher than 1, 2 % (in volume) showing a nutrition declaration on the label, the declaration can only present the energy value.[18] The energy value and the amounts of nutrients must be expressed per 100 g or 100 ml and optionally, per portion and/or rations, as already provided by art. 6 of Directive 496/90, but the portion or serving must be clearly quantified on the packaging.[19] Both the

[12] Art. 34, par. 2, states that mandatory information defined according to art. 30, paragraphs 1 and 2, can be shown in line if the space on the product does not allow to include a table.

[13] Art. 29, Regulation (EU) 2011/1169.

[14] Art. 30, par. 1, Regulation (EU) 2011/1169.

[15] Art. 34, par. 5, Regulation (EU) 2011/1169.

[16] Art. 30, par. 2, Regulation (EU) 2011/1169.

[17] Art. 30, par. 5, Regulation (EU) 2011/1169.

[18] Art. 30, par. 4, Regulation (EU) 2011/1169.

[19] Art. 32, par. 2, Regulation (EU) 2011/1169.

Vitamin A (µg)	800	Chloride (mg)	800
Vitamin D (µg)	5	Calcium (mg)	800
Vitamin E (mg)	12	Phosphorus (mg)	700
Vitamin K (µg)	75	Magnesium (mg)	375
Vitamin C (mg)	80	Iron (mg)	14
Thiamin (mg)	1,1	Zinc (mg)	10
Riboflavin (mg)	1,4	Copper (mg)	1
Niacin (mg)	16	Manganese (mg)	2
Vitamin B6 (mg)	1,4	Fluoride (mg)	3,5
Folic acid (µg)	200	Selenium(µg)	55
Vitamin B12 (µg)	2,5	Chromium (µg)	40
Biotin (µg)	50	Molybdenum (µg)	50
Pantothenic acid (mg)	6	Iodine (µg)	150
Potassium (mg)	2 000		

Fig. 6.2 Vitamins and minerals which may be declared and their nutrient reference values (NRVs). *Source* Annex XIII of Reg. (EU) 2011/1169

Table 6.3 Comparison between Nutrition Labelling ruled by Dir. 90/496/EEC and Nutrition Declaration ruled by Reg. (EU) 2011/1169

	Dir. 90/496/EEC	Reg. (EU) 2011/1169
Food	Pre-packaged	Pre-packaged (and not packaged, on national basis)
Compliance	Voluntary	Mandatory
Nutrient fundamentals	Energy (kcal,-kJ), protein, carbohydrate, fat	Energy (kcal,-kJ), fat (saturated), carbohydrate (sugars), fibre, protein, salt/sodium
Voluntary additional nutrients fundamentals	Starch, polyols, mono-unsaturates, polyunsaturates, cholesterol, any of the minerals or vitamins listed in the Annex of Dir. 90/496/EEC	Starch, polyols, mono-unsaturates, polyunsaturates, fibre, any of the minerals or vitamins listed in the Annex of Reg. (EU) 2011/1169
Presentation	Per 100 g/ml or per serving size, with % RDA	Per 100 g/ml or per serving size, with % reference intake
Lay-out	No	Declaration shall be presented in the principal field of vision, and with a specific font size
Cholesterol	Admitted	Not admitted
Salt	Sodium	Salt
Reference intake	% RDA	Reference intake both for micro and macro nutrition fundamentals

Source Authors' elaboration from Dir. 90/496/EEC and Reg. (EU) 2011/1169

mandatory and additional information can be shown in % of the amount suggested by the Daily Guideline Amount (the so-called GDA), with the statement "reference intake for an average adult (8.400 kJ/2000 kcal)".[20] Table 6.3 indicates the main changes between Directive 90/496/EEC and Regulation (EU) 2011/1169.

[20]Art. 32, paragraphs 4 and 5, Regulation (EU) 2011/1169.

In December 2014, the provisions of the Regulation (EU) 2011/1169 came into force. However, the nutrition declaration will be mandatory starting from the end of 2016, as stated in Article 55 of the Directive. The European legislator seems to urge food companies in the immediate implementation of such labelling, according to art. 54, paragraph 3, which establishes that even before December 2014, foodstuffs bearing the information covered by articles 29 to 35 of the Regulation (EU) 2011/1169 could be launched on the market.

Comparison Between the EU Nutrition Declaration and the USA Facts Panel

In 2010, a FAO report prepared by Albert (2010) proposed an in depth review on the nutrition labelling format in several countries. Results of such a study reveal that in 2010, the regulation on nutrition labelling varied worldwide according to the categories illustrated in Table 6.4, which show evidence of the FAO report updated with the analysis published by EUFIC, in January 2015 (European Food Information Council 2015).

According to the elaboration illustrated in Fig. 6.3, there is a sort of homogeneous distribution across geographical areas with regard to the level of stringency regarding nutrition labelling. However, the European Union will be added to the group of countries with a mandatory nutrition labelling on mostly pre-packaged foods by the end of 2016. The fact that most countries "require nutrition labelling when a claim is made, is a reflection of the guidelines from the Codex Alimentarius Commission" because

Table 6.4 Authors' elaboration from Albert (2010, p. 41) and EUFIC (2015)

Regulation category (level of stringency)	Country
No regulation	Bahamas, Barbados, Bermuda, Belize, Dominican Republic, Haiti, Honduras, Bangladesh, Pakistan, Cambodia, Ghana, Jamaica
Guidelines on format and nutrient list for voluntarily applied nutrition labels	Bolivia
Voluntary unless a nutrition or health claim appears on the food or except on foods with special dietary uses	Switzerland, Costa Rica, Ecuador, Egypt, El Salvador, Guatemala, Brunei, Singapore, Vietnam, South Africa, Tunisia, Turkey, Morocco, Jordan, Venezuela, Lebanon, Kenya, Nigeria, Mauritius
Mandatory on all packaged foods	Australia, New Zealand, Canada, USA, Argentina, Brazil, Chile, Paraguay, Uruguay, Hong Kong, Israel, EU[a], Mexico, Colombia, India, Indonesia, China, South Korea, Malaysia, Taiwan, Russia, Japan, Saudi Arabia, Kuwait, Oman, Qatar, United Arab Emirates, Bahrain, Philippines, Thailand

[a]The nutrition labelling will be definitively mandatory for all pre-packaged foods by the end of 2016

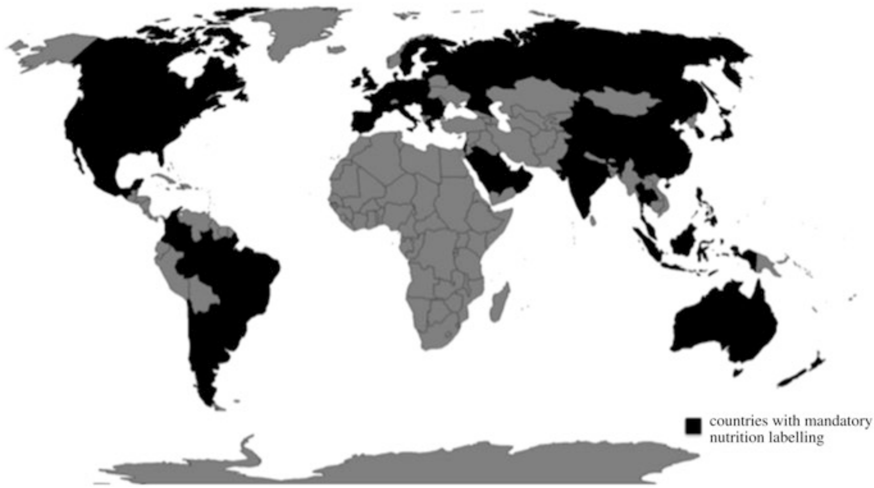

Fig. 6.3 Countries with mandatory nutrition labelling

the "Guidelines on Nutrition Labelling (CAC/GL 2_1985, revised 1993) state that nutrition labels should only be required when a nutrition claim is made" (Albert 2010, p. 40). With regard to the format, additional differences exist among countries worldwide. Although it is commonly accepted that the basic nutrition label is to include energy, plus protein, total fat and carbohydrate, some countries require the additional disclosure about fibre, saturated fat and sodium, or salt, or about particular groups of vitamins (Albert 2010). In particular, in relation to differences between the EU nutrition labelling according to Regulation (EU) 2011/1169 and the Nutrition Facts Panel in the USA, it has to be noted that the latter emphasizes the role of serving size, while providing consumers direct information about the proper amount of food to be consumed in order to satisfy real energy—and health—needs. To this purpose, the serving size and other features of the Nutrition Facts Label are currently being updated in order to better meet emerging consumer needs on nutrition information and face new issues related to nutrients of public health significance. The serving size is easily understood by consumers with respect to the numeric information that has to be interpreted. However, the interpretation of numeric nutrition data assumes that consumers have the necessary knowledge about nutrition fundamentals and are familiar with proper diet composition and correct energy intake. As mentioned in Introduction, a pilot consumer research conducted by the authors has revealed that consumers do not really know the correct daily intake of each nutrient. Therefore, the serving size should be measured according to real nutrition needs, and not real average consumption. In the second case, a serving size measured on the large portion, very frequent in many developed countries, may worsen eating habits. Reviewing the serving size by the FDA is important, because it registers changes in eating habits that have occurred in the last 20 years, namely from the introduction of the mandatory nutrition facts panel. In addition, the FDA has proposed to renew the nutrition labelling design in order to make calories and serving sizes more prominent. In this way, the parts of the label that are important to current public health concerns are emphasized. Some concerns refer to the fact that the FDA would intend to increase—duplicating, or even triplicating—the serving size, according to actual average consumption in the US.[21] This is partially in disagreement with the last food-based dietary guidelines—the USA—issued in 2010 by the US Department of Health and Human Services (HHS) and the US Department of Agriculture (USDA), which have introduced a different way of showing the serving or daily plan, represented by a plate with large portions of fresh vegetables and fruits (HHS and USDA 2010), already shown in Chap. 3. The serving size in the EU nutrition labelling is optional, while the amount of cholesterol is not required (not even optionally), whereas in the US, the Nutrition Facts Label is mandatory. The US nutrition labelling also indicates the type of fat in detail—saturated and trans—and in addition to their total amount, the FDA has proposed to complete the information about sugar presenting the amount of added sugar, because it increases calorie intake and reduces the intake of nutrient-rich foods. The aim of these details is to highlight which products are highly processed. Finally, in the Nutrition Facts Label, each nutrition fundamental is indicated per Daily Value (DV) percentage, which is calculated on an average intake of 2,000 calories. This means that the Nutrition Facts Label mostly relates to the male average intake. The total amount is not fully reported because it is shown in comparison to a threshold.

In Europe, the nutrition declaration is mandatory for all pre-packaged food products (with exceptions listed in article 16, paragraph 4, article 44, paragraph 44 and appendix V), while fresh foods or foodstuff packed on point of sales do not apply the declaration, unless Member States adopt specific national rules. In the USA, nutrition labelling is not mandatory for fresh foods, and raw single-ingredient food—even if frozen—packaged by the retailer falls "under the voluntary nutrition labelling program. However, for the retail store to be in compliance with the voluntary program, nutrition labelling information must be available at the point of purchase (i.e., be displayed in close proximity to the product)" (FDA 2013). In conclusion, information on calories is increasingly being required in the last few years, also for restaurants (Albert 2010), which already have to display the Nutrition Facts Panel in an appropriate box, if they use claims to promote their foods. The main differences between the EU Nutrition Regulation and the US Nutrition Facts Label are summarized in Table 6.5.

[21]As shown on the web page of FDA: Proposed Changes to the Nutrition Facts Label. Available at http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm385663.htm#images, retrieved in April 2015.

Table 6.5 Comparison between Nutrition Declaration ruled by Reg. (EU) 2011/1169 and Nutrition Facts Panel ruled by NLEA 1990

	Reg. (EU) 2011/1169	NLEA 1990
Food	Pre-packaged (and not packaged, on national basis)	Pre-packaged retail, different from meat and poultry
Compliance	Mandatory	Mandatory. Restaurants using claims must display nutrition information in appropriate boxes
Nutrient fundamentals	Energy (kcal,-kJ), fat (saturated), carbohydrate (sugar), fibre, protein, salt/sodium	Energy (kcal,-kJ), fat (saturated and trans), cholesterol, sodium, carbohydrate, fibre, sugar, protein, Vitamin A, calcium, iron
Voluntary additional nutrients fundamentals	Starch, polyols, mono-unsaturates, polyunsaturates, fibre, any of the minerals or vitamins listed in the Annex of Reg. (EU) 2011/1169	Calories from saturated fats, mono-unsaturates, polyunsaturates, potassium; soluble fibre; alcohol; other carbohydrates; other vitamins and minerals for which they were established reference Daily Intakes, RDI; beta-carotene (as a percentage of vitamin A)
Presentation	Per 100 g/ml or per serving size, with % Reference intake	Per serving size
Lay-out	Declaration shall be presented in the principal field of vision, and with a specific font size	Table, nutrition fundamentals shall be presented in the principal field of vision, and with a specific font size
Cholesterol	Not admitted	Mandatory
Salt	Salt	Sodium
Reference intake	Reference intake both for micro and macro nutrition fundamentals	Reference daily values per protein and micronutrients, dietary reference values per macronutrients

Source Authors' elaboration from Reg. (EU) 2011/1169 and NLEA 1990

Conclusion

Rules on nutrition labelling largely differ worldwide, but last trends highlight that there is a sort of convergence towards a compulsory label. In particular, the (EU) 2011/1169 Regulation illustrates a comprehensive framework able to protect expectations of both consumers and food companies, although it is the result of a simplification of previous rules. Indeed, it is a unique regulation harmonizing the norms on label, nutrition labelling, presentation and promotion of food products, and on the presence of allergenic ingredients. Regulation (EU) 2011/1169 has maintained the general scope and guidelines of the previous norm on nutrition labelling, Directive 90/496/EEC, and has introduced significant novelties, which try to meet stakeholder expectations. The first innovation, mostly targeted on consumer needs, is the introduction of the mandatory application for all prepacked food products, with only few exemptions. The mandatory nutrition declaration has been designed to be flexible, in order to allow companies to be in compliance with the norm by the end of 2016, and continue innovation in future so as to compete worldwide without decreasing on consumer protection. The comparison between the EU Nutrition Declaration and the US Nutrition Facts Label shows that additional improvements can be added to the European label, in order to increase direct understanding of nutrition information by consumers. In agreement with the US rules, the EU Nutrition Declaration could highlight the serving size, which is currently just an optional presentation (per 100 g/ml or per portion). Serving size can indeed help consumers when consuming, but it has to be properly measured on the bases of different consumer needs, first of all, that of getting correct information to help plan a healthy diet. The serving size used refers to average data on a portion, calculated in different ways from country to country. In the USA for instance, serving sizes are the reference amounts customarily consumed per eating session.[22] In order to properly support consumers in choosing food products in agreement with their real physiological needs, these reference amounts should also be calculated by taking into account the suggested dietary intake. However, the latter varies according to personal features and poses several issues in identifying the correct average data to use as reference.

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Chapter 7
Claims and Other Front of Package Information

Abstract At present, nutrition labelling is not so effective in guiding consumer purchasing behaviour because many consumers prefer a simpler way providing nutrition information which can help them in assessing nutritional characteristics of a particular foodstuff quickly. In response to the obvious need to developing a more effective presentation of nutritional information, which should convey this information in a simplified and systematic manner, manufacturers and retailers from different countries have created some systems for signalling the nutritional profile. For nutritional information of the greatest interest to be easily perceived by consumers, they have used various schemes marked on the front side of individual packages—generically called Front of package (FoP). FoP schemes of nutrition information have an important role in food choices because they reduce cost related to efforts in looking for information about nutritional properties and health effects. Given the importance arising from FoP schemes, which include nutrition and health claims as well as graphical nutrition labelling, international legislators have tried to rule these ways to present nutrition information in order to assure consumers a higher level of protection. Although created in order to facilitate healthy food choices, the effect of these FoP systems on consumers is indeed controversial.

Front of Package Systems Indicating Nutrition Information to Consumers

Recent surveys on European consumers showed that the latter seem to understand the content of nutrition labelling, but they do not make use of it for their food choices (EUFIC 2015). Among the obstacles related to a correct use of nutritional labels, there is a lack of cognitive skills required in using these labels in order to compare products and interpret nutrients in the context of diet as a whole, as well as time constraints in reading labels in real purchasing situations (Wartella et al. 2011). Evidence shows that "consumer's ability to interpret nutrition information

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decreases with the complexity of the task (European Heart Network 2007, p. 8)". In particular, consumers seem to consider graphical schemes and other Front of Package (hereinafter FoP) claims more helpful in the prompt evaluation of the nutritional characteristics of a foodstuff, so that these really enable them in making healthy choices (Lynam et al. 2011; Möser et al. 2010). With time, producers and sellers of food products have developed several simplified FoP schemes to represent the nutrition value of foodstuffs, with the support of industrial associations and organizations. These FoPs have been designed in order to support rapid choices by consumers; moreover, they have to be very attractive and easily recognizable. In this way, FoPs are really useful to consumers because they provide information which is able to support consumers in creating food purchasing awareness, thereby leading them to a healthier diet (Kelly et al. 2009). Basically, it is possible to summarize FoP schemes into two main groups. The first includes nutrition and health claims, while the second mostly refers to the several forms of graphical nutrition labelling. These FoP schemes have changed the notion of nutrition information incorporated in the label. Products indicating health benefits have an increasing market value, and, in such a context, FoP labels are mostly marketing tools since they are able to communicate healthy food properties to consumers easily and promptly (Albert 2010). Over the last few years, the global food industry has continued innovating with regards to FoP tools, thereby leading legislators to taking care of this phenomenon in order to guarantee a higher level of consumer protection. The increasing attention on the role of diet and health should not result in misleading the consumer with respect to nutritional or health attributes associated to foodstuffs. The legislator should act promptly so as to prevent potential fraud.

Nutrition and Health Claims

In international literature, several studies on consumer behaviour in relation to nutrition and health claims exist (Pothoulaki and Chryssochoidis 2009; Williams 2005), while evidence as regards understanding of health claims seems rare (Grunert et al. 2011; Drichoutis et al. 2006). A survey carried out by *Which*?—the UK Consumers Association—has highlighted that the majority of British consumers could not fully understand the information provided by nutrition claims: the majority of respondents were not aware of the meaning of *fat-free* or *low-fat* claims, for instance (European Commission 2003). Other studies performed in the United States and Australia have proved that the format of health claims influences understanding of the claim, and the perceived positive effect on human health, due to consumption of the product (Roe et al. 1999; Wansink 2003; Chan, Patch and Williams 2005; Singer et al. 2006; Kapsak et al. 2008; Feunekens et al. 2008; Hooker and Teratanavat 2008). On the other hand, the increasing interest in nutrition and healthy foodstuff properties, which can be classified as *experience* and *credence* features (Darby and Karni 1973; Stigler 1961; Nelson 1970), leads consumers to making their food choices on the basis of nutrition and health claims, which are simpler to interpret (BEUC 2005). Recent developments in international regulations will probably affect the future of producing and marketing of foodstuffs using nutrition and health claims. Indeed, the need to protect consumers from misleading messages has led most worldwide legislators to reinforcing the regulation system for the application of nutrition and health claims. The first regulation on foods with specific labels suggesting healthy or nutrition benefits was established in Japan in 1991. In particular, a dedicated law for the application of *other function claims* for a certain group of foods known as *Foods for Specified Health Use* (hereinafter FOSHU) was established (Tee 2002). FOSHU are specifically designated for health uses, such as reducing high levels of cholesterol, blood pressure, glucose and so on (Shimizu 2002). Moreover, these Japanese regulations cater for the use of several functions, nutrient content and nutrient comparative claims (Tee 2002). At the beginning of the 90s, the US FDA introduced the Nutrition Labelling and Education Act (hereinafter NLEA) to rule nutrition labelling, while nutrition and health claims have been permitted since 1994, under the Food, Drug and Cosmetic Act, as amended that same year by NLEA. The Codex Alimentarius Commission, founded by FAO and WHO in 1963, with the purpose of developing general guidelines for promoting consumer health and fair trade at international level, implemented the General Guidelines on Claims in 1997—CAC/GL 1-1979—for the use of nutrition and health claims. In accordance with the CAC/GL 1-1979, a nutrition claim means "any representation which states, suggests or implies that a food has particular nutritional properties, including but not limited to the energy value and content of protein, fat and carbohydrates, as well as vitamins and minerals". Rules that allow claims on the content of specific foodstuffs as well as comparative claims are laid down in the Guidelines. In particular, comparative claims compare the presence of nutrients or the energy value of two or more foodstuffs. Although the European legislator had set the first rules for nutrition labelling and advertising on foods in 1979, with the Directive 79/112/EEC (European Council 1979), it was only in July 2007 that an extensive regulation on nutrition and health claims became applicable, following a long law-making process that ended in December 2006, when the European Parliament and Council approved Regulation (EU) 1924/2006 (European Parliament and Council 2006a) and Regulation (EU) 1925/2006 (European Parliament and Council 2006b). The first step of this long law-making process was the Directive 90/496/EEC (European Council 1990). This rule established that food products with a nutrition claim, which "means any representation and any advertising message which states, suggests or implies that a foodstuff has particular nutrition properties due to the energy it provides, provides at reduced or increased rate, or, does not provide, and/or due to the nutrients it contains, contains in reduced or increased proportions, or does not contain",[1] had to also present nutrition labelling.[2] In addition, in 1994, the European Council

[1]Art. 1, paragraph 4, (b) Directive 90/496/EEC.

[2]Art. 2, paragraph 2, Directive 90/496/EEC.

approved the Directive 2991/94/EEC (European Council 1994), which allowed the *reduced-fat* claim for products with an amount of fat between 41 % and 62 %, and the *low-fat* and *light* claims for those products with an amount of fat below 41 %. However, prior to the advent of these Regulations, the use of claims was controlled at Member State level. According to a recent study, before entering into the force of regulations 1924/2006 and 1925/2006, 14 Member States had a specific regulation for the use of nutrition and health claims (Hieke et al. 2015). Hence, this lack of a uniform approach limited the free movement of food across the EU (Gilsenan 2011). In fact, the European legislator has been driven by the dual objective of providing a higher level of consumer protection and guarantee, as well as free movement of goods and homogeneous conditions of competition (Asp and Bryngelsson 2008). Therefore, in order to guarantee consumer protection and prevent different regulations in force in the European Countries from hindering free movement of foodstuffs, the European Commission proposed the introduction of a specific legislation on nutrition claims (European Commission 2000) in the White Paper on Food Safety of January 2000. The first step for a community regulation on nutrition labelling has led to the drafting of a Discussion Paper by the Directorate General, for Health and Consumers (DG SANCO) in the European Union, which has laid the groundwork for a shared definition of nutrition claims and their field of application among more than 90 agents, including Member States, consumer associations and food industries (European Commission 2001). In such a context, some considerations on the suitability of the *diet* label emerged. Indeed, diet products are often intended as a synonymous of light foods, but can be easily confused with dietetic products, specifically disciplined by Directive 89/398/EEC (European Council 1989), which refers to foodstuffs for people with a specific diet. At the end of the consultation, and after three years of work, the European Commission presented the proposal for the Regulation on nutrition and health claims (European Commission 2003) to Parliament and Council in July 2003. In December 2006, the legislative process eventually came to an end with the approval of Regulation (EU) 1924/2006 on nutrition and health claims, and the Regulation (EU) 1925/2006 on the addition of vitamins and other substances to foods, directly citing the *source of* claim. These Regulations have defined the rules of application of nutrition and health claims, stating that the former have to follow the list of claims suggested in the annex of Regulation (EU) 1924/2006, and the latter need adequate scientific support and a higher level of clarity in expression.[3] In addition, health claims promoting a reduction of the risk of disease[4]—adding some of the other substances ruled by Regulation (EU) 1925/2006, for instance—have to overcome a more stringent approval process.[5] This set of rules aims at shedding light into the diversified world of nutrition labelling, by reconciling the opinions of the Member States and

[3]Art. 13, Regulation (EU) 1924/2006.

[4]Art. 14, Regulation (EU) 1924/2006.

[5]Art. 15, 17, 18, Regulation (EU) 1924/2006.

international provisions of the Codex Alimentarius (Codex Alimentarius Commission 1979). However, definitions and handling of claims still differ considerably in Europe, Japan and the USA (Aschemann-Witzel and Hamm 2010). In the USA, claims on food are grouped into three categories, namely nutrient content claims, structure/function claims and health claims, quite similar in nature to their European equivalent, even if approval procedures are very different. In Japan, the FOSHU law only requires some evidence. Originally, in the USA the allowed health claims had to be supported by Significant Scientific Agreement (hereinafter SSA), but since 2003, the *qualified health claims* are also legally permitted if they provide a disclaimer stating the lower level of scientific evidence (Lupton 2009). On the contrary, the European legislator requires a high level of scientific substantiation concerning health claims, reinforced by the European scientists' opinion that does not favour qualified health claims (Verhagen et al. 2010). However, the same rigour does not seem to have been applied to the EU rules on nutrition claims. Table 7.1 shows the main differences and similarities between US laws and EU regulations on nutrition and health claims. With particular regard to health claims, as mentioned above, two levels currently exist in the US: health claims and qualified health claims.

The former kind of health claims still has to comply with the SSA standard, while the latter must be simply accompanied by a disclaimer. In addition, in the US, functional foods are ruled as products labelled with structure/function health claims, similar to Japan. These products contain a nutrient or dietary ingredient, which are intended to affect the structure or function in humans, or that characterize the documented mechanism by which a nutrient or dietary ingredient acts to maintain such structure or function (FDA 2013). In Europe, art. 13 of Regulation (EU) 1924/2006 basically covers function claims, although these are not clearly defined, falling under the umbrella of health claims. The EU regulation does not admit differentiated levels of scientific proof, and all kind of health claims have to be definitively approved by the European Food Safety Authority (hereinafter EFSA), and once approved, the European Commission can integrate the new health claims into the regulation.

Graphical Nutrition Labelling

Graphical nutrition labelling includes voluntary FoP schemes represented in graphical form, which promotes nutrition or health benefits. These graphical labels are usually, but not exclusively, placed on the front of the food package (Albert 2010). Five main groups of graphical nutrition labels exist: health-related symbols (Hieke et al. 2015), traffic light labelling, guideline daily amount (GDA) labels, nutrition scoring systems and calorie labelling (Albert 2010). In general, graphical nutrition labels are a recent phenomenon, because first symbols were introduced at the end of the 80s. Table 7.2 shows the most important health-related graphical symbols.

Table 7.1 Definition and conditions for use of nutrition and health claims according to European regulations and US laws. *Source* Regulation (EU) 1924 and FDA, Label claims: http://www.fda.gov/Food/IngredientsPackagingLabeling/LabelingNutrition/ucm2006873.htm. Accessed May 2015

	European union		USA	
	Definition	Conditions for use	Definition	Conditions for use
Nutrition claims	**Nutrition claim** means any claim which states, suggests or implies that a food has particular beneficial nutritional properties due to energy… nutrients or other substances	Nutrition claims shall only be permitted if they are listed in the Annex and are in conformity with the conditions set out in Regulation (EU)1924/2006	**Nutrient content claim** is a claim on a food product that directly or by implication characterizes the level of a nutrient in the food	Only those claims, or their synonyms, that are specifically defined in the regulations (21 CFR 101.13, Subpart D of part 101, and parts 105 and 107. 21 CFR 101.13(b)) may be used. All other claims are prohibited
Health claims	**Health claim** means any claim which states, suggests or implies that a relationship exists between a food category, a particular food or one of its constituents, and health: Reduction of disease risk claims and claims referring to children's health and development	Application for authorisation to be sent to the national competent authority of a Member State, which in turn, has to send the application to EFSA	**Health claims** include those statements, symbols, vignettes or other forms of communication that suggest, within the context in which they are presented, that a relationship exists between the presence or level of a substance in the food and a disease or health-related condition	Health claims are required to be reviewed and evaluated by the FDA. Health claims are required to be revised and assessed by the FDA prior to use
				FDA regulations provide a list of health claims to be used
				A firm may also submit a health claim notification based on an authoritative statement by a U.S. government scientific body under Sect. 403(r)(3)(c) of the FD&C Act
				Health claims are generally revised by the FDA through a petition process

(continued)

Table 7.1 (continued)

	European union		USA	
	Definition	Conditions for use	Definition	Conditions for use
		The application must also contain a copy of the studies, including independent, peer-reviewed studies where available, which have been carried out with regard to the health claim, and any other available material to demonstrate that the health claim complies with the criteria provided for in this Regulation; a copy of other scientific studies which are relevant to that particular health claim	**Qualified health claims**, as Health Claims, characterize a relationship between a substance (specific food component or a specific food) and a disease or health-related condition, and are supported by scientific evidence (see 21 CFR 101.14)	Qualified health Claims are subjected to an interim procedure
			They refer to statements about diet/disease relationships for which science supporting the claim did not meet the SSA standard	They must be accompanied by a disclaimer or otherwise qualified
Function claims	**Health claims other than those referring to the reduction of disease risk and to children's development and health** (function claims, for instance)	List of permitted claims. A food business operator intending to use a health claim not included in the provided list has to submit an application similar to that requested for the other health claims, but the authorization process should be more rapid	**Structure/function claims** may describe the role of a nutrient or dietary ingredient intended to affect the normal structure or function of the human body. In addition, they may characterize the means by which a nutrient or dietary ingredient acts to maintain such structure or function	These three types of claims are not pre-approved by the FDA, but the manufacturer must have substantiation that the claim is truthful and not misleading, and must submit a notification with the text of the claim to the FDA no later than 30 days after marketing the dietary supplement with the claim itself
				If a dietary supplement label includes such a claim, it must state in a "disclaimer" that FDA has not evaluated the claim

(continued)

Table 7.1 (continued)

	European union		USA	
	Definition	Conditions for use	Definition	Conditions for use
			General well-being claims describe general well-being from consumption of a nutrient or dietary ingredient	The disclaimer must also state that the dietary supplement product is not intended to "diagnose, treat, cure or prevent any disease", because only a drug can legally make such a claim
			Nutrient deficiency disease claims describe a benefit related to a nutrient deficiency disease (like vitamin C and scurvy), but such claims are allowed only if they also state how widespread the disease is in the United States	If the label or labelling of a product marketed as a dietary supplement bears a disease claim, the product will be subject to regulation as a drug, unless the claim is an authorized health claim for which the product qualifies
			Structure/function claims for conventional foods focus on effects derived from nutritive value, while structure/function claims for dietary supplements may focus on non-nutritive as well as nutritive effects	The FDA does not require conventional food manufacturers to notify the FDA about their structure/function claims, and disclaimers are not required for claims on conventional foods

Table 7.2 An overview of worldwide health-related graphical symbols

Name	Year	Symbol	Lead organization	Aim	Country
Heart-check mark	1987		American Heart Association	To advise consumers that a foodstuff is heart friendly (Wartella et al. 2011)	US
Keyhole	1989		Swedish National Food Administration	To help consumers identify healthier options within a food category when buying food, and it is also widespread in Denmark, Norway and Iceland[a]	Sweden
			Norwegian Directorate of Health and the Norwegian Food Safety Authority		Norway
			Danish Veterinary and Food Administration		Denmark
Pick the tick	1989		Australian Heart Foundation	To help guide consumers towards a healthier product, when compared to similar products, while standing in a supermarket aisle[b]	Australia
Protects health scheme	1995		Slovenian Heart Foundation	To indicate foods meeting specific nutritional criteria (e.g. low cholesterol food, rich in fibre) and therefore heart friendly (Stockley 2006)	Slovenia
Health check	1999		Heart and Stroke Foundation of Canada	To inform consumers that the food or menu item has been reviewed by registered dieticians from the Heart and Stroke Foundation, and can contribute to an overall healthy diet[c]	Canada

(continued)

Table 7.2 (continued)

Name	Year	Symbol	Lead organization	Aim	Country
Heart symbol	2000		Finnish Heart Association and Finnish Diabetes Association	To inform consumers directly that the product is the better choice in its category with regard to fat (quantity and quality) and sodium[d]	Finland
GI symbol	2002		Glycemic Index Limited	To indicate products with glycemic index tested at an accredited laboratory, and meet strict nutrient criteria for kilojoules, saturated fat and sodium, and where appropriate, fibre and calcium. The nutrient criteria are consistent with international dietary guidelines[e]	Australia New Zealand
Smart spot	2004		PepsiCo	To support consumers in easy recognize Pepsi products that contribute to healthier lifestyles[f]	International
The sensible solution	2005		Kraft International	To identify those products that represent "better for you" dietary choices as compared with other products within the same category[g].	International
Be treatwise	2006		Confectionery Trust	It is a trade mark that operates to educate and inform: it is the most recognized of all education tools in the food industry and its message is designed to ensure a responsible consumption of confectionery as a treat, which may be enjoyed as part of a balanced diet and healthy lifestyle[h]	Australia
Helthy choice	2006		Choice International Foundation	To help consumers make healthy food choices and stimulate producers to develop healthier products. Choices criteria, based on solid science, determine if a product is qualified to carry the Choices logo[i]	International

(continued)

Table 7.2 (continued)

Name	Year	Symbol	Lead organization	Aim	Country
Fruits and veggies—more matters	2007		National Cancer Institute Centres for Disease Control	To ensure products and recipes promoting the brand offer an overall healthy nutrient profile[j]	US
Healthier choice symbol and healthier snack symbol	2009		Health Promotion Board	To support consumers in easily recognizing products lower in total fat, saturated fat, sodium and sugar. Each food category has a separate set of nutritional criteria to adhere to[k]	Singapore
Healthy ideas	2009		Giant Food	To help consumers shop for truly healthy foods in Giant Food stores[l]	International

[a]Seehttp://www.livsmedelsverket.se/en/food-and-content/labelling/nyckelhalet/. Accessed May 2015
[b]See http://www.heartfoundation.org.au/healthy-eating/heart-foundation-tick/Pages/default.aspx. Accessed May 2015
[c]See http://www.healthcheck.org/page/helping-you-eat-well. Accessed May 2015
[d]See http://www.sydanmerkki.fi/en. Accessed may 2015
[e]See http://www.gisymbol.com/gi-symbol/. Accessed May 2015
[f]See https://www.niehs.nih.gov/news/assets/docs_p_z/summary_informationtaaffe_508.pdf. Accessed May 2015
[g]See http://www.esasnacks.eu/ukadvpledge_companies_mondelez.pdf. Accessed May 2015
[h]See http://www.betreatwise.info/aboutus.php. Accessed May 2015
[i]*See* http://www.choicesprogramme.org. Accessed May 2015
[j]See http://www.fruitsandveggiesmorematters.org/about-fruits-and-veggies-more-matters. Accessed May 2015
[k]See http://www.hpb.gov.sg/HOPPortal/health-article/2780. Accessed May 2015
[l]See http://giantfood.com/live-well/health-and-wellness/. Accessed may 2015

The UK Coronary Prevention, a Non-Governmental Organization (NGO), launched the proposal for the Traffic light labelling system in the early 1990s (Coronary Prevention Group 1992). However, only in 2006 did the UK Food Standards Agency (hereinafter FSA) implement this approach in order to help consumers overcome their difficulties in understanding nutrition labelling, and, make healthy food choices (Stockley 2008). The FSA defined a consistent traffic light labelling system based on separate information on key nutrients (fat, saturated fat, sugar and salt) and the use of colours to provide information on the level of individual nutrients in the product at a glance (high is red, moderate is yellow, low is green)—(Borgmeier and Westenhoefer 2009), as shown in Fig. 7.1. Several health organizations support the Traffic Light format because it is clear and simple to understand at the point of sale (Sacks et al. 2009). It declares nutritional values for 100 g or 100 ml of foodstuff. In this way, manufacturers seem not to have much space in handling the nutritional profile, as happens in case of serving portion. Although this scheme is voluntary, the FSA called on food retailers and manufacturers to adopt the Traffic light system to encourage a consistent approach, but with enough flexibility. This is because the existence of several and differentiated schemes may further confuse consumers (Albert 2010). Indeed, previous analyses on consumer perception of the Traffic Light system highlighted that consumers have problems using this scheme, and sometimes the perceived healthiness of the product changes among consumers in relation to their personal interpretation of this graphical label (Savoie et al. 2013). It can be noted, for instance,

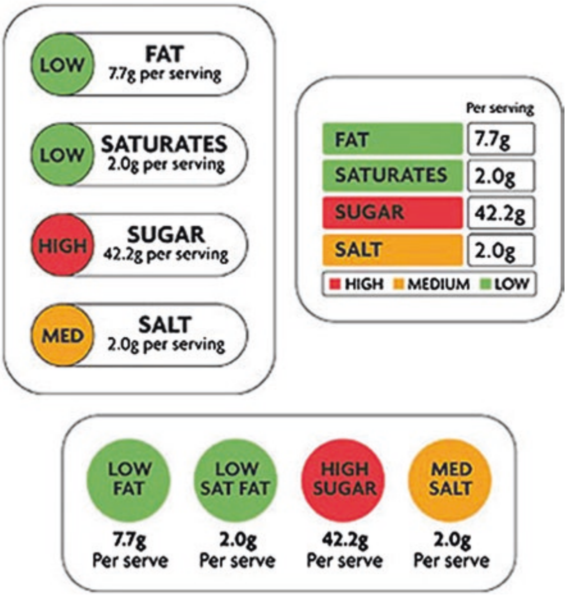

Fig. 7.1 Traffic light schemes. *Source* http://www.foodpolitics.com/wp-content/uploads/fsafoodlabels.jpg. Accessed May 2015

Table 7.3 Some results from main studies on consumer perception of FoP schemes and nutrition information

Authors	Results from consumer perception studies
Grunert and Wills (2007)	Nutrition principles do not have the same weight in consumers' food choices because they are more interested in calories and fat, followed by salt and sugar
Balcombe et al. (2010) Hieke and Wilczynski (2012)	Consumers place greater importance on a change in a nutrient characteristic from red to amber compared with a change from amber to green
Wartella et al. (2011)	The traffic light system poses some disadvantages for certain food categories, for dairy products, for instance, which contain a high amount of saturated fat, but also many beneficial nutrients

that the Traffic Light system is unable to support choice awareness in case of similar products with the same combination of red, yellow and green. Other critics to the Traffic Light format from consumer perception studies are reported in Table 7.3. These criticalities also explain the reasons why the Traffic Light system is still very unpopular within the food industry, although many manufacturers have adopted it.

The Daily Amount Guideline (hereinafter GDA) was first developed by the UK Institute of Grocery Distribution (IGD) approach. Given the obtained support by the food industry, GDA labelling was then implemented and diffused by the leading food industry trade group in Europe, the Confederation of Food and Drink Industries in the EU (hereinafter CIAA), as from 2006. The European Commission and the European Parliament gave their support to the CIAA GDA labelling because it proved the commitment of partners participating in the European Platform for action on diet, physical activity and health. This platform is a European Commission initiative devoted to concretely committing food companies in promoting a healthy diet in Europe, with measurable actions. Without using different colours, the GDA scheme graphically shows the amount of energy and key nutrients contained in one portion of food—or beverage—as a percentage of the reference values (Sanitarium Health and Wellbeing 2011), which represent an energy estimate, and nutrient needs for healthy adults, based on *daily amount* guideline (i.e. the amount of energy/nutrients recommended that an average person should consume per day). In particular, in addition to the delivered energy, the GDA label also reports the sugar content, total fat and saturated fat and salt per serving size. The daily recommended values for an adult woman with average level of activity, because it is considered appropriate for most population needs, are calories—2000 kcal, protein—50 g, carbohydrates—270 g, sugars—90 g, fat—70 g, saturated fat—20 g, fibre—25 g and sodium/salt—2.4/6 g. GDA label should work as a guide in consumer choices because it easily provides the energy and macronutrients intake that most people are advised to consume daily for a healthy diet (Fletcher 2006).

In this way, consumers can easily recognize how each food or beverage product impacts their daily nutritional needs, and they are able to choose products for their balanced diet. However, since the GDA label is based on the expression of the quantity of energy and nutrients, consumers need to look at this information carefully in order to create food choice awareness. In addition, this system focuses only on quantitative values, without taking the quality of the food product into consideration. Finally, the more critical consumer segments—namely, children, pregnant women and the elderly—are not really supported by the GDA label because it refers to nutrition needs of an average healthy adult.

Nutrition Scoring and Calorie Labelling

Other graphical labels are also diffused, mostly in the United States, such as the nutrition scoring and calorie labelling. The former is mainly used in supermarkets, while the latter is applied by several restaurants and chain restaurants (Albert 2010). In particular, in 2008, the supermarket retailer Hannafords introduced the Guiding Stars scheme, a graphical score system based on stars: one star means good nutritional value; two stars mean better; and three stars indicate the best. The Guiding Stars received patent protection in 2011 and the Guiding Stars Licensing Company[6] has been constituted. A product without stars is a foodstuff that does not fall into one of these three categories. Stars are applied according to a patented algorithm, which uses information from the Nutrition Facts Panel and the ingredients list. This score system is also used for fresh foodstuffs and products of all brands. Similar to the Guiding Stars, the NuVal Nutritional Scoring system evaluates the nutrient profile of food on a scale from 1 to 100, in which the higher score represents higher nutrition value. It works with all kinds of foods. The NuVal score was developed by an independent panel of nutrition and medical experts in 2008, and is determined by the Overall Nutritional Quality Index (ONQI®), which takes into account 30-plus nutrients and nutrient factors, and their effects on health.[7] The NuVal score positioned close to the price aims at helping consumers make better decisions about food choices rapidly, showing the Guiding Stars labels and an example of NuVal scores and its position (Fig. 7.2).

Calorie labelling is mostly represented by calorie information regarding restaurant menus, also called menu labelling. First introduced in 2008 by Yum Brands! for company-owned outlets—including Pizza Hut, KFC and Taco Bell, for instance—throughout the United States, it has became mandatory in many US cities since 2009, and when President Obama signed the Affordable Care Act in

[6]See: http://guidingstars.com. Accessed May 2015.

[7]See: http://www.nuval.com. Accessed May 2015.

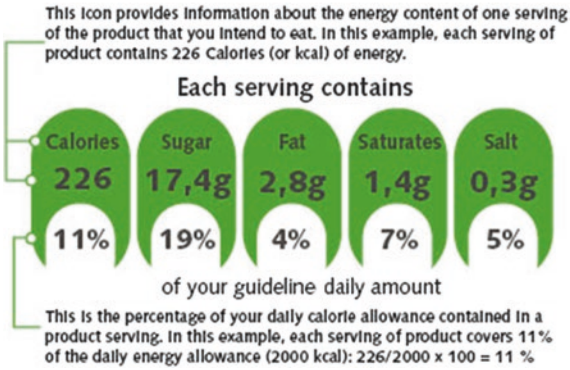

Fig. 7.2 Example of guideline daily amount label. *Source* http://www.eufic.org/article/en/nutrition/food-labelling-claims/artid/Making_sense_of_Guideline_Daily_Amounts/. Accessed May 2015

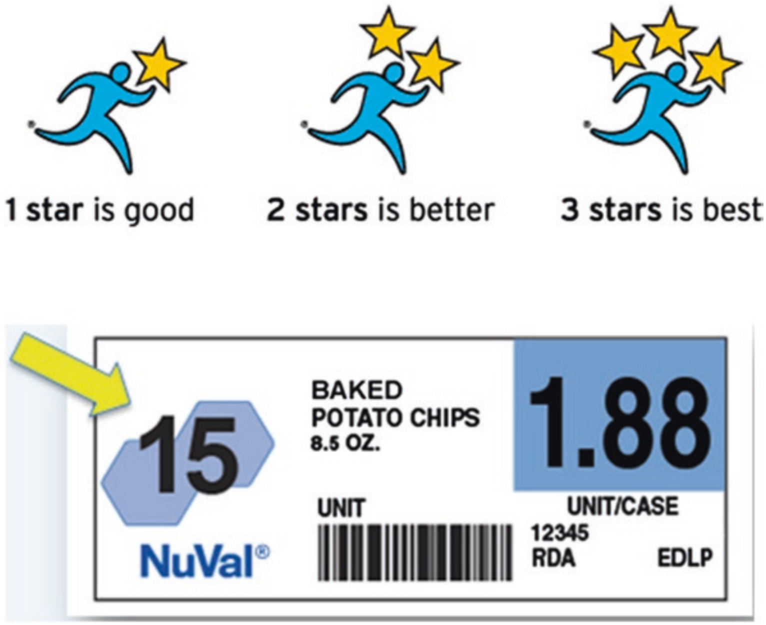

Fig. 7.3 Guiding stars (**a**) and NuVal Score (**b**). *Source* a http://guidingstars.com/what-is-guiding-stars/; b http://www.nuval.com/products. Accessed May 2015

2010, menu labelling went national.[8] At the end of 2014, the FDA also finalized two rules for providing calorie information on menus and menu boards in chain restaurants, and similar retail food establishments and vending machines[9] (Fig. 7.3).

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[8] See: http://www.foodpolitics.com/tag/calorie-labeling/. Accessed May 2015.

[9] See: http://www.fda.gov/Food/IngredientsPackagingLabeling/LabelingNutrition/ucm217762.htm. Accessed May 2015.

Graphical Labelling in the Regulation (EU) 1169/2011

Regulation (EU) 1169/2011 ruled ways of presenting the nutrition declaration and other systems, to show—graphically or not—nutrition information on the front of food packages (European Parliament and Council 2011). With regard to the mandatory nutrition declaration, the first two paragraphs of article 34, which is specifically devoted to the regulation of the Presentation, state that both the mandatory information as well as the voluntary disclosure are shown in clear format, and possibly included into a table.[10] Moreover, this information shall be presented in the same field of vision, although its position is not clearly defined.[11] The third paragraph in article 34 seems to really regulate all kinds of permitted FoPs because it states that pre-packed foods applying the mandatory nutrition declaration can also repeat the energy value, or the energy value together with other nutrients—the amounts of fat, saturates, sugars and salt[12]—and this information shall be shown on the principal field of vision with an adequate font size in order to guarantee clear readability for the consumer. In addition, this information can be also shown in different formats, suggesting the use of graphical systems, for instance.[13] Similarly, non-pre-packed foods and alcoholic beverages can also apply a different format to indicate the above-mentioned nutrition information. This way, the use of FoPs, different from nutrition and health claims, is ruled both in content and positioning, and does not leave much freedom to manufacturers. Finally, article 35 states that the energy value and the amount of mandatory nutrients can be shown in different formats—also specifying graphical forms or symbols—from those suggested by Regulation (EU) 1169/2011, if these forms respect several conditions, which aim at protecting consumers from misleading messages about the real quality of food products. In particular, only adequate forms of expression emerging from a widespread consultation of stakeholders, and based on strong scientific evidence from investigations on consumers, are allowed, in order to facilitate consumer understanding about nutrition information, and the free movement and commercialization of food products among Member States.[14] The latter can also recommend manufacturers to make use of a specific and different forms of expression or presentation of nutrition information, included in the mandatory declaration. In this case, Member States have to guarantee monitoring of the application of such a form, and manufacturers have to notify the EFSA about its application. The European Commission will have to report to Parliament and Council about the efficacy of these different forms introduced by Members States and their effects on the market by the end of 2017. This report will aim at further harmonizing formats

[10]Art. 34, paragraphs 1 and 2, Regulation (EU) 1169/2011.

[11]Art. 34, paragraph 1, Regulation (EU) 1169/2011.

[12]Art. 30, paragraph 3, Regulation (EU) 1169/2011.

[13]Art. 34, paragraph 3, Regulation (EU) 1169/2011.

[14]Art. 35, paragraph 1, Regulation (EU) 1169/2011.

of presentation of nutrition information.[15] Indeed, the presence of several and differentiated FoP systems could mislead consumers, in particular, if the information shown is difficult to compare (Grunert and Wills 2007). Indeed, the lack of standardization of FoPs, such as the different uses of colours, does not help consumers in creating food choice awareness. Conversely, a standardized FoP system can also drive producers to improving quality as well as the nutritional profile of foodstuffs, in order to be able to apply FoP to promote their products. Therefore, provisions of article 35 of Regulation (EU) 1169/2011 can really lead to a unique FoP system, useful to both consumers and food producers. In this context, the monitoring activity on new FoPs application by Member States and the EFSA is very important because it allows the European Commission to define a common and shared unique format of presentation on nutrition information, in addition to the declaration that can effectively support consumers in comparing food products and allow them in creating healthier food consumption awareness.

Conclusion

Regulations (EU) 1924 and 1925 of 2006 and 1169 of 2011 have tried to clarify the diversified world of FoP systems, in order to deliver few and clear labels which can help consumers in choosing proper foods for a healthy diet, without limiting innovation capabilities of food companies and free trade among Member States. The difficulty of such an attempt, which is made worse by the rather slow pace of the full actuation process of regulations, gives rise to concerns on their effectiveness, especially in the light of what is being offered nowadays on supermarket shelves. Over the last few years, an increasing amount of new food products claiming nutritional or health properties has been introduced on the market. Different kinds of nutrition and health labels have been experimented in order to help consumers improve their nutritional intake. However, this way appears too easy and simple to run in order to achieve the above-mentioned goal. Indeed, it seems quite difficult that coloured labels or attractive claims can lead to improving consumer diet towards healthier eating. In any case, consumers should have adequate knowledge on nutrition to understand the effects each food has on their health, in order to choose those products making up a diet that is really able to contribute to their wellness. For this purpose, acting on consumer knowledge of nutrition is the first step to usefully improve their protection. Therefore, as the main result of this long European regulatory process on nutrition information, a limited set of clear formats is expected and easy to be applied by food producers. These formats should effectively help the consumer in making comparisons among different foods for healthier choices. However, it is also desired that mandatory educational pathways on correct diet and adequate nutritional intakes—even in the form of promotional campaigns at the point of sales, or using new information technologies—be introduced in the next few years in all Member States.

[15]Art. 35, paragraphs 2 to 6, Regulation (EU) 1169/2011.

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Index

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