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Trends in the Food and Sports Nutrition Industry: A Review

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ABSTRACT: This revision intends to provide an overview on the major and emerging trends in food and nutrition. Food scientists and dietitians should keep an eye on the trends shaping the food industry in order to understand consumer changes in preferences, expectations and dietary patterns; and to identify those areas that should be added to the research agenda. In addition, to comprehend the major drivers of change in the food industry, global consumer trends are also reviewed in this article. Global concerns are shaping consumer attitudes, and with an easier access to information and an unprecedented consumer power through social media, the food industry should quickly adapt to meet consumer needs. In order to meet these objectives, this review is organized in three different but interrelated sections: global consumer trends, food and nutrition trends, and trends in sports foods and nutrition. This last one is also included due to its influence over food trends, and its significant relevance as a category and food trend.

Keywords: food trends, food industry, nutrition, sports nutrition, consumer.

Table of contents:

Introduction

The development of new food products is influenced by numerous factors, but among them, global dynamics stand out. Demographics, socioeconomics, culture, politics and environment have a great impact on consumer lifestyles and dietary patterns. In fact, global issues such as climate change, global population aging, child exploitation, food waste, unfair trade or animal abuse, among others, are shaping consumer attitudes towards healthy, plant-based, sustainable and socially conscious food purchases (The Nielsen Company, 2018a). It has to be noted that, thanks to the irruption of new technologies, consumers not only have an easier access to information, but also an unprecedented power to lobby for change (Euromonitor International's Head of Lifestyles Research, 2017).

In this context, and in order to adapt formulas and technologies to consumer needs, food scientists should keep an eye on the major and emerging trends shaping the food industry. Understanding consumer changes in preferences and expectations is vital when developing new products (PriceWaterhouseCoopers [PwC], 2013). Moreover, global dynamics have an influence on nutrition trends, thereby impacting dietary patterns and being potentially disruptive for the correct balancing of the diet. For this reason, not only food scientists, but also dietitians should be aware of the emerging trends that will influence food and nutrition in the coming decades.

The aim of this review is to provide an overview of the current food trends, identifying the areas that are more prone to development, and thus, that should be added to the research agenda. In addition, due to its influence over food trends, and its relevance as a category and food trend, sports foods and nutrition are also reviewed in detail (European Specialist Sports Nutrition Alliance [ESSNA], 2018), (Euromonitor, 2015b). Global consumer trends are also addressed in this review in order to understand the major drivers of change in the food industry. Finally, this review is organized in three different but interrelated sections: global consumer trends, food and nutrition trends, and trends in sports foods and nutrition.

Global Consumer Trends

In 2018, with a stronger global economy, consumer expenditure is expected to grow as its strongest rate since 2011 (Euromonitor International's Head of Lifestyles Research, 2017). However, shifting consumer attitudes will continue shaping changes in business.

Clean-living and activist consumers

Consumers are becoming activists due to an increased awareness of global issues through Internet and social media; which at the same time give consumers an unprecedented power to lobby for change (Labrecque, vor dem Esche, Mathwick, & Novak, 2013). Consumer opinions are far-reaching, and they feel that their spending choices can make a difference (Labrecque et al., 2013). Concerns about climate change and health are widespread among consumers, especially the younger who are adopting a clean-living lifestyle. Clean lifers have strong beliefs and ideals, and they are embracing a minimalist, balanced and healthier lifestyle to reduce harm to themselves, others and the environment (Euromonitor International's Head of Lifestyles Research, 2017). Furthermore, they are demanding companies a greater transparency, sustainability and social responsibility (Kearney, 2010), (Kang & Hustvedt, 2014).

Personalization, a trend across all industries

Besides going greener, consumers are seeking uniqueness, demanding to be involved in the production process and product personalization (Wind & Rangaswamy, 2001). Although customization is demanded in all industries, from sneakers and furniture, to services and experiences; there is a rising interest in personalized health and beauty (Euromonitor International's Head of Lifestyles Research, 2017). Genetic findings related to health, fitness and nutrition, as well as a rising interest in health, and a growing consumer curiosity about their genetics, are fueling demand for DNA testing (Subbiah, 2007), (Ferguson, 2013).

Informed and connected consumers are shaping changes

Millennials, also known as "the connected generation", are driving the consumer revolution. Mobile devices are nowadays vital for everything, including shopping, sharing experiences, or health and sport tracking among others (Deloitte, 2013). Health technologies, including wearables and fitness apps, have made

people more aware of their state of health, powering the growth of health and wellness market (L. G. Euromonitor International's Consumer Health Analyst, 2016). In fact, people tend to exercise more, with gym memberships in the United States of America (US) increasing by more than 20% for the period comprised between 2011 and 2016 (Business Development Bank of Canada [BDC], 2016).

Thanks to new technologies, consumers are more informed about their choices and reject unmeasured or uninformed spending. Ownership is under question and sharing is gaining popularity (Hamari, Sjöklint, & Ukkonen, 2016). A new wave of apps aims to provide consumers with the opportunity to share everything, from cars to living spaces (The Economist, 2013). Consumers prefer spending their money on experiences like travels, festivals and restaurants, rather than on products (Euromonitor International's Head of Lifestyles Research, 2017). Buying time, such as adopting online shopping and ordering food for delivery, is also a trend on the rise (L. G. Euromonitor International's Consumer Health Analyst, 2016). For this reason, an increased growth rate in apps and mobile optimized websites is forecasted.

Global consumer trends in brief

Thanks to the irruption of new technologies, consumers' opinion is more powerful than it has ever been. For this reason, concerns about climate change, health and social responsibility, which are widespread among consumers, may shape changes in business. Other important trends are personalization and shared economy; as well as seeking for experiences or saving time rather than buying products. Finally, millennials will lead the mobile-driven market transformation, as they expect to do everything by using their mobile phone.

Food and Nutrition Trends

Global trends have the power to transform and disrupt entire categories, such as nutrition. One of the aforementioned global trends, clean/healthy living, stands out as the most relevant trend impacting the food industry. Connected and informed consumers are going back to nature and unprocessed foods, to preserve most of the natural vitamins and minerals. For this reason, there's a growth in plant-based, organic, naturally healthy and "free-from" foods. Clean label is also a trend on the rise, and while healthy snacks and fats are

coming back, sugar and certain carbohydrates are becoming the main enemies. Protein, instead, is the preferred food component. Other trends such as personalization, redefinition of indulgence foods, activist consumers, and Internet of Things (IoT), are shaping changes in consumer behaviors and therefore, in the food industry. However, the most relevant nutrition trend is the rise of sports nutrition category.

Older population growth – increased focus on health care

As both the proportion of older people and the average life expectancy increase throughout the world, the older population is growing dramatically worldwide; and therefore, the incidence of chronic diseases (Global Burden of Disease Study 2013 collaborators, 2015). In fact, in about five years' time, the number of people aged 65 or older, will outnumber children under age 5; representing a forecasted 16% of world's population by 2050 (World Health Organization [WHO], 2015b). Population aging is placing pressure on overall health care spending in developed countries, and for this reason, governments are interested in promoting healthy habits to reduce morbidity and cut off its associated health-care costs. In this spirit, the World Health Organization (WHO) released "Active ageing: a policy framework" in 2002 to prevent and delay chronic diseases and premature mortality, as well as their risk factors (WHO, 2015a).

In line with WHO's health action plan, and thanks to consumer connectivity and access to information, there is an increased attention on health care (Kearney, 2010). For this reason, by 2020, a double-digit growth has been predicted for health and wellness market in the US. In addition, an increasingly number of consumers are seeing food as a medicine, and as a consequence, dietary supplements and sports nutrition stand out as one of the fastest growing healthcare categories, with an expected growth of 14% over the next few years in the US (BDC, 2016).

Connected consumers, informed decisions: going greener and healthier

With an easier access to information, consumers are becoming more aware than ever of ingredients in their food and their properties. In order to make informed decisions, consumers seek transparency throughout the production process to understand what is in their food and how it was produced (Bjørndal, Fernandez-Polanco, Lappo, & Lem, 2013), (Kang & Hustvedt, 2014). Clean lifers are turning their backs on unhealthy

habits, food waste and animal-based products. They want to feel good about their consumption choices by eating healthily, sustainably and ethically (Radnitz, Beezhold, & DiMatteo, 2015). Nowadays, eating often carries an ideological charge similar to belonging to a political party or football club (Euromonitor, 2015a). In fact, in 2018, 67% of US consumers said that they will be prioritizing healthy or socially conscious food purchases (The Nielsen Company, 2018a). Even fast food is getting greener, and there is a decrease in reliance on animal-based nutrition. The vegetarian and vegan movement are already in full-swing, and on the next years we will see a further push to eradicate or reduce animal-based products (Hancox, 2018), (Radnitz et al., 2015).

- *Vegetarian and vegan diets on the rise*

The proportion of individuals choosing to follow a vegan diet has increased in the recent years, with ethics and health being the main reason for such choice (Radnitz et al., 2015). As a result of consumer interest, vegan sales growth is outpacing total food and beverage sales (The Nielsen Company, 2018b). When it comes to health benefits of vegetarian eating, current scientific evidence reinforces benefits of a plant-based diet that is low in fat, added sugars, added salt, and processed foods. A healthy and well-planned vegan diet, with a high content of fruits, vegetables and wholes grains, can provide sufficient energy and an appropriate range of carbohydrate, fat and protein intakes to support performance and health (Venderley & Campbell, 2006). In fact, many top athletes, including world champions like Venus Williams and Lewis Hamilton, are vegan, thereby contributing to a vegan consumer base expansion (Edsor, 2017).

In line with this growing consumer interest, global market for vegetarian and vegan products was worth US$51bn in 2016, but it is still expanding, with a 987% increase in demand for vegetarian products (The Vegan Society, 2018). In the same year, a 3% of the US population ate a strictly vegetarian diet, and about half of those were vegan. But the biggest revelation was that 36% of consumers opted for at least some vegetarian meal on a regular basis (Vegetarian Resource Group, 2016). In the United Kingdom (UK), the number of vegans quadrupled in the years between 2014 and 2018, reaching a 1,16% of the population (The Vegan Society, 2018). Indeed, as shown in Figure 1, vegan trend tripled in the years between 2012 and 2018 (Google Trends, 2018). In line with this rapidly growing consumer demand for vegetarian and

vegan products, big companies such as Danone, McDonald's or Ben&Jerry's have invested in vegan alternatives to their products (The Vegan Society, 2018).

To sum up, consumers are keener on more plant-based, natural, minimally processed, local and seasonal food. According to Euromonitor International Global consumer trends survey 2017, "all natural" is the preferred food attribute, followed by "no artificial sweeteners", "limited or no added sugar" and "does not contain Genetically Modified Organisms (GMO) ingredients". In line with these findings, the following categories are on the rise (Euromonitor, 2017a).

- *Organic food growth*

Consumers are moving towards products perceived as more natural and healthier, resulting in a global demand for organic products (Asioli et al., 2017). Global sales of organic food and drink expanded by about 10% to US$81,6bn in 2015. The highest growth was observed in North America, which has the largest market for organic food and drink in the world. Valued at US$43,4bn and accounting for over half of international sales, it is followed by the European market, which is valued at US$31,1bn in 2015. Asia, Australasia and other regions, account for just US$7,2bn in 2015. Despite having had an enormous growth, from US$18 to 82bn over 15 years, organic food drink and sales growth is expected to continue (Sahota, 2012), (FIBL and IFOAM, 2017). In fact, by 2019, 30% growth is forecasted for organic beverages in Canada (BDC, 2016).

When it comes to the organic packaged food and beverages, in 2016 they had a global retail value RSP of US$32,153mn and US$3,972.7mn, respectively (Euromonitor, 2015a). And in 2018, in Latin America, organic and "free-from" packaged food, are worth US$35bn and US$36bn; and will have annual growth rates of about 6% and 3,5%, respectively, thereby standing out as one of the food categories with a global strongest growth (Daniells, 2018).

- *"Free-from" and digestive wellness*

Specific ingredients and even entire categories or food groups, such as dairy, lactose, sugar, sodium, gluten, meat, fats and carbohydrates, are being avoided or limited by an increasing number of consumers (International Food Information Council Foundation, 2018). 68% of US consumers are concerned with what is not in their food (The Nielsen Company, 2018a), and those who avoided at least five separate ingredients increased from 35% in 2015, to 53% in 2016 (L. G. Euromonitor International's Consumer Health Analyst, 2016).

In the same year, global free-from foods were valued at US$33bn, and have consolidated as the category with the most dynamic growth in the health and wellness market (Euromonitor, 2017b). Consumers perceive "free-from" offering as healthier, and they associate it to digestive wellness and gut health. For this reason, free-from trend has gone beyond intolerance and allergies, as consumers increasingly focus on foods that may help them to reduce feelings of gas, bloating or more severe gastrointestinal symptoms related to suspected allergies or intolerances (Mintel, 2016), (Kerry Health And Nutrition Institute [KHNI], 2018). As a consequence, "free-from" products, as well as added-benefit ingredients such as probiotics and prebiotics are on the rise. When it comes to the largest subcategory, free-from dairy is leading, due to an increased demand for dairy milk alternatives. It is followed by free-from gluten, which had the largest absolute growth over the period between 2012 and 2017 (Euromonitor, 2017b). In fact, in 2015, 12% of new food products launched in the UK carried a gluten-free claim (Mintel, 2016).

- *Naturally healthy vs. fortified and functional food*

Functional foods are those containing added biologically active ingredients that may improve health or lower the risk of disease. Besides supplying macronutrients, vitamins and minerals, they may include other active ingredients like antioxidants, prebiotics, probiotics, enzymes and/or phytonutrients to deliver a specific health benefit above their basic nutritional value (Bigliardi & Galati, 2013).

Functional food term encompasses a wide variety of products, like those enriched or fortified. Enrichment involves replacing those nutrients lost during processing. An example is bread, often enriched with iron and

folic acid, which are removed during milling of wheat to make flour (WHO, 2018), (Overview of Food Fortification, 2003). Fortification, instead, involves adding nutrients irrespective of whether they were originally present to any great extent in the food. Fortification is mostly used to improve nutritional status of a population or to differentiate products providing a competitive advantage. For example, bread may be fortified with omega-3 fatty acids (Gökmen et al., 2011). Nutrients are also usually added to substitute products in order to achieve a similar nutritive value to that in the original product. An example is the addition of calcium to soya-based drinks, which are sold as cow's milk substitute, in an amount equal to milk's natural content (Yazici, Alvarez, Mangino, & Hansen, 1997).

On the other hand, naturally healthy products are those that naturally contain active ingredients. An example is oatmeal, which contains a soluble fiber that can help lower cholesterol levels and heart disease risk (Othman, Moghadasian, & Jones, 2011), (Bernstein et al., 2013). In line with the clean-living trend, more consumers like the idea of whole plant-based foods with intrinsic nutritional value, and thus, without the need for fortification. This is leading to a decrease in demand for functional foods. In fact, naturally healthy, valued at US$253bn, has already outpaced global fortified and functional food and beverage market, which is valued at US$247bn (M. M. Euromonitor International's Consumer Health Analyst, 2018). Despite functional food category growth slowing down, this category is still expanding and important, especially in emerging markets, where consumers are seeking functional ingredients linked to a health positioning (Kearney, 2010).

<u>Clean label, no longer a trend but the new norm</u>

"Clean label" concept doesn't have any commonly accepted definition, and it is more based on consumer perception rather than on scientific evidence. Clean label products are those made with ingredients that consumers recognize and trust, and that do not contain undesirable ingredients (Asioli et al., 2017), (Bizozzero, 2017). Clean labeling usually involves reducing the number of ingredients, particularly those perceived to be artificial, and those lacking any nutritional benefit. Mainly focused on removing food additives, such as synthetic colors, preservatives, stabilizers, emulsifiers and texturizers; clean labelling in its purest form also involves reducing certain food components such as fat, sugar and salt among others.

Claims such as “all natural”, “no artificial sweeteners”, “limited or no added sugar”, “non-GMO” and “minimally processed” are often included in clean label products (Asioli et al., 2017).

In line with the aforementioned global trends, consumers are increasingly mindful of their food and beverage choices. 69% and 52% of worldwide consumers believe, respectively, that products without artificial ingredients, and products with fewer ingredients, are healthier (The Nielsen Company, 2016). For this reason, consumers are willing to pay more for clean label products, whose global sales hit US$165bn in 2015 and are projected to reach US$180bn by 2020 (Bizozzero, 2017).

Clean label products are no longer a trend but the new norm (Bizozzero, 2017). Ingredient names, and especially consumer familiarity and acceptance of them, play a central role in clean-label. Long, chemical-sounding, difficult-to-pronounce or unfamiliar names lead to perceptions of higher risk and raise questions about the reason for their use in foods (Asioli et al., 2017). Therefore, clean labeling often includes swapping chemical-sounding names for consumer-friendly ones. By way of example “tocopherol”, a synonym of vitamin E, might be perceived as chemical or artificial, so it would be better to list it as vitamin E. However, going clean label is not always such an easy task (Gallagher, Gormley, & Arendt, 2004). For this reason, the replacement of ingredients regarded as redundant, unacceptable or even harmful without any scientific justification sets up costly and sometimes unnecessary challenges. In addition, as previously mentioned, clean labeling is more about consumer perception than scientific evidence. With a constantly changing consumers’ wish-list, so does the target for formulators, whom at the same time have to face functionality, quality and safety issues derived from the replacement of certain ingredients (Lamacchia et al., 2014).

Protein is king, fat is back, and what about carbohydrates?

While consumers try to avoid specific ingredients, others are on the rise. Consumers are increasingly looking for high-protein foods, since an optimal protein intake is usually associated with satiety and lean body mass gain or maintenance (Euromonitor, 2016). Protein also serves as a great replacement for sugar and fat, which are usually linked to an unhealthy diet (Lucca & Tepper, 1994). With 55% of US consumers considering high protein content a remarkable attribute when buying food products, protein demand is

increasing (The Nielsen Company, 2017). However, it still has room to grow, especially in emergent markets.

When it comes to the reasons for this protein surge, media praise and sports nutrition have a lot to do with it. Protein dominates sports nutrition global sales, as it is an accessible and understandable ingredient, which gives multiple health benefits (C. S. Euromonitor International's Consumer Health Analyst, 2014). It appeals mainly to younger consumers aligned with fitness trends, but with an increasing evidence of benefits on aging, bone and heart health, it will potentially appeal to millions more in the near future (Euromonitor, 2016).

As for the sources of protein, skinless chicken, fish, egg white and lean beef are the best dietary sources of low fat and high-quality protein (Hoffman & Falvo, 2004). While traditional sources like meat, eggs and dairy are consumer's primary sources of protein and still dominate sales (as illustrated in Figure 2), plant-based alternatives are experiencing a strong growth, in demand for health, sustainability and animal rights (The Nielsen Company, 2017).

It should be pointed out that fat, which is usually associated to an unhealthy diet, is an essential component of all cells, and along with carbohydrates, provides the majority of energy to individuals who exercise at a low-to-moderate intensity (Melzer, 2011). "Fat is back" is a trend in agreement with the dietary recommendation that the type is more important than the amount of fat (KHNI, 2018). Certain fats such as polyunsaturated omega-3 fatty acids found in fish and other foods, have a number of reported positive health effects, like mitigating inflammation (Calder, 2010). Other examples of healthy fat's sources would be olive and avocado, which are rich in monounsaturated fatty acids (Owen et al., 2000), (Dreher & Davenport, 2013). Finally, fats also have a technological function, serving as texturizers or as a way to add flavor. The last one is gaining relevance as a result of an increased focus on sugar reduction (KHNI, 2018).

Last but not least, there is a growing concern about the source and content of carbohydrates. They have been targeted by many weight-loss diets as a strategy to reduce overall calorie intake, resulting in a rising

popularity of carb-free foods (International Food Information Council Foundation, 2018). When it comes to its source, minimally refined grains and faux grains like quinoa, amaranth or wild rice, are gaining popularity due to their nutritional profile with increased protein content and a low glycemic index (Peters, 2018). In contrast, consumers try to avoid sugars or starches, which are often referred to as “bad carbs” due to their minimal nutritional value. This is strongly linked with the plant-based food trend, as carbs derived from fruits or vegetables are considered as “good carbs”, and are used instead of refined starches (KHNI, 2018).

Beverages, snacks and indulgence foods redefined

Due to the aforementioned scientific evidence against added sugars and energy drinks, beverages are in a redefinition phase. Functional beverages like kombucha and protein shakes are gaining popularity among consumers, who are keener on beverages that incorporate protein, fiber and vegetable servings, while maintaining an acceptable flavor (KHNI, 2018). In functional beverages, stevia is usually the sweetener of choice for people who want to cut down sugar or calories (Lemus-Mondaca, Vega-Gálvez, Zura-Bravo, & Ah-Hen, 2012).

When it comes to snacks and indulgence foods, they are being reformulated so that they contain more plant-based and/or perceived as healthy ingredients. In addition, due to busier lifestyles, an increasing number of consumers prefer a snackable meal format, which is more convenient than sit-down meals. This is a growing food trend, known as “snackification” (KHNI, 2018).

Activist consumers against food waste

With half of the world’s food being thrown away, there is an increased concern about food waste (McCarthy & Liu, 2017). For this reason, consumer acceptance of “non-perfect” products will grow, and consumers will begin to consider cheap food past its best before date. A revival in use of leftovers, right-size portioning and grow-it-yourself, is also forecasted (Euromonitor, 2015a). Finally, as consumers are keener on new initiatives encouraging more sustainable production and targeting food waste, governments are also making a move. In fact, in France, a law was approved to make supermarkets give food waste to charity or as animal feed (Sénate Français, 2016).

Personalization, a global trend impacting nutrition

As discussed above, personalization is one of the main global trends, which is also influencing nutrition trends. A new wave of companies provides consumers with genetic and metabolomic findings related to their health, fitness and nutrition (Subbiah, 2007). Additional information can be collected through wearable fitness trackers, among other methods; giving an overall picture of health. Personalized training and nutrition plans are offered based on findings of individual parameters such as fat burning ability or capacity to metabolize caffeine, lactose or gluten, among others (Mutch, Wahli, & Williamson, 2005), (Ferguson, 2013). In this context, one of the main challenges of personalization is not just customizing mass-produced products, but also shaping them to individual preferences before production, in order to shift from product to experience or service (Wind & Rangaswamy, 2001), (Euromonitor International's Head of Lifestyles Research, 2017).

Internet of Things shaping interaction with food

By the year 2020, about 24 billion internet-connected devices will be installed globally, which is the equivalent of about 3 devices/person (Gubbi, Buyya, Marusic, & Palaniswami, 2013). IoT may continue shaping the way we purchase, receive and interact with our food. In fact, there is a continued expansion of online or online/offline hybrid subscription services, such as click and collect grocery shopping and delivery of restaurant meals. Due to strong growth of these alternative businesses, it is expected that by 2021, supermarkets and hypermarkets will account for less than a half of the total consumer goods trade (Euromonitor, 2018).

Sports nutrition is rocketing

In line with the aforementioned healthy living trend, more people are adopting an active lifestyle, which is translating into a rise of sport and endurance activities (C. S. Euromonitor International's Consumer Health Analyst, 2014). As scientific evidence confirms that certain ingredients can enhance athletic performance, more people recognize the benefits of sports nutrition products, and therefore, are increasingly complementing their work-out sessions with these products (American Dietetic Association et al., 2009),

(Ronald J. Maughan & Shirreffs, 2012). For a long time, sports nutrition products were primarily meant and used by the so-called core users, that is, elite athletes and bodybuilders. However, the growing health consciousness and desire for fast results has helped sports nutrition to become more appealing to mainstream consumers and thereby, to expand its consumer base over the last decade. The so-called casual users have pushed the category into the mass market (Euromonitor, 2015b). For this reason, products that were once only available in fitness shops, can now be found in pharmacies and even supermarkets, achieving greater total sales for the sports nutrition category (Spano & Antonio, 2008).

Sports nutrition was valued at US$8,8bn in 2013; and sports foods comprising protein supplements, sports nutrition, and soft drinks including energy and sports drinks, were valued at US$60bn in the same year (C. S. Euromonitor International's Consumer Health Analyst, 2014). Despite having experienced a steady rate growth in the last decade, several market researches continue forecasting a sustained global growth for sports nutrition category in the following years (Euromonitor, 2015b). Last but not least, although it has been reviewed as a nutrition trend, sports nutrition is also a category itself, with its own wide range of specific trends, and for this reason it will be reviewed in detail in the corresponding section below.

Nutrition trends in brief

To sum up, global trends and concerns about climate change, health and social responsibility, which are widespread among consumers, are shaping changes in nutrition. As a consequence of the clean-living trend and the older population growth, there is an increased focus on healthy nutrition and physical exercise to prevent and delay aging, chronic diseases and premature mortality, as well as their risk factors.

Consumers seek transparency, and with an easier access to information, they are becoming more aware than ever of ingredients in their food. Consumption choices are influenced by the will of eating healthy, but also ethically and socially conscious. For this reason, consumers are keener on more natural, animal-free, plant-based, minimally processed, local, and seasonal food. Besides going back to nature, with a growth in demand for organic and naturally healthy products, other categories such as "free-from" and fortified/functional foods are also on the rise.

In line with the clean labelling trend, certain ingredients or categories, such as dairy, sodium, sugar or carbohydrates, are being avoided or limited by an increasing number of consumers. Instead, other ingredients such as proteins or healthy fats, are becoming more popular. With health as the main priority, even beverages, snacks and indulgence foods, are being redefined to incorporate ingredients with demonstrated health benefits.

Other global trends such as personalization, activist consumers against food waste, and IoT, are shaping interaction with food and impacting nutrition. Sports nutrition is rocketing and influencing nutrition trends, possibly being the main responsible for the protein surge. For this reason, and because it is not only a nutrition trend, but also a category itself, it will be reviewed in detail in the section below.

Finally, by way of a summary, Figure 3 shows the global sales of the selected health categories in 2017, reflecting their relevance among the different health categories.

Trends in Sports Foods and Nutrition

Global trends and consumer concerns are shaping changes in nutrition, and thereby influencing the sports nutrition category as well. “Healthy living” stands out as the most relevant global trend impacting the food industry, and it is responsible for the enormous growth that sports nutrition category is experimenting. In line with this increased health awareness, consumers are keener on more natural, animal-free, plant-based, minimally processed, local, and seasonal food, what is also shaping sports nutrition products.

As more consumers become aware of the importance of a well-designed diet for a good training, the use of sports nutrition products is becoming mainstream. Besides being a nutrition trend, it is an important category influencing nutrition trends, possibly being the main responsible for the protein surge. Sports nutrition is a large and quickly growing consumer health category that promotes the achievement of an optimum nutrient intake, which is having positive implications in health care costs and well-being, and for this reason it will be reviewed in detail below.

480

481 Sports nutrition, not just a recent trend

482 Sports foods are those specialized products designed for athletes and active people to improve their
483 nutritional intake, health, wellbeing, performance, muscle growth and/or recovery from exercise. In addition,
484 they can also provide a convenient source of nutrients when it is impractical to consume everyday foods.
485 Whey protein, sports gel or electrolyte replacement drinks are examples of sports foods. Among sports
486 foods, sports nutrition encompasses food/dietary supplements aimed to contribute to an optimal
487 performance (ESSNA, 2018). By law, sports nutrition products can only contain vitamins, minerals, food
488 ingredients, macronutrients, herbal ingredients with a substantial history of use, and other ingredients that
489 are generally regarded as safe (European Parliament, 2002), (United States Congress, 1994). Despite the
490 distinction between sports foods category and sports nutrition subcategory, the two terms are often used
491 interchangeably, also in the following text.

492

493 Although sports nutrition is one of the latest trends, it is a much older phenomenon. In the ancient Olympic
494 Games, athletes used to eat massive quantities of meat, bread, dried fruits and honey, along with various
495 fungi and herbs in an attempt to increase their athletic performance. But it was not until the last century
496 when scientists found that certain substances were effective in improving athletic performance, and thereby,
497 the first scientific-based sports nutrition products were created (ESSNA, 2018). A well-designed diet, with
498 nutrient-dense foods, that meets energy intake requirements and incorporates proper timing of nutrients, is
499 the foundation of a good training (Kerksick et al., 2008). However, athletes' dietary needs might be difficult
500 to achieve through food intake alone, and for this reason, dietary supplements and sports nutrition products
501 are often needed. When races are won by mere fractions of a second, and games may be lost due to
502 fatigue, nutrition can make the difference between an athlete and a champion (Spano & Antonio, 2008).

503

504 Until recently, only bodybuilders and strength athletes were pushing for nutrient-dense, high-quality, and
505 more convenient sources of nutrition, that could help them satisfy their unique nutritional requirements.
506 However, as a consequence of an increasing scientific evidence on sports nutrition health and performance
507 benefits, more athletes and coaches from other disciplines, embraced the use of these products. In the last

decade, sports nutrition has expanded its consumer base to amateur athletes and active people who not only care about their muscle growth, athletic performance and recovery, but also about their health and wellbeing (Euromonitor, 2015b), (C. S. Euromonitor International's Consumer Health Analyst, 2014).

Sports nutrition market analysis

Consumers worldwide are adopting a healthy living lifestyle and gaining awareness of their needs and proactive steps that can be taken to achieve a higher wellbeing and prevent chronic diseases (Euromonitor International's Head of Lifestyles Research, 2017). Along with this trend, different categories are growing, like the Canadian wearable device market, which includes fitness trackers, and is expected to grow by 150% in 2019. Another example would be that in 2014, more than 41% of Canadians were interested in buying a health monitor (BDC, 2016). So, with health in focus and with the rising mantra "strong is the new skinny", sports nutrition is the fastest growing consumer health category for several years in a row, and it is expected to continue growing at a steady pace in the next years (Mitchell, 2016).

Since more people recognize the benefits of sports nutrition products, the category has seen an enormous growth, from US$6,7bn and US$8,9bn in 2010 and 2013, respectively, to US$10,8bn in 2015. Moreover, forecasts point out that it will continue growing. Sports foods, including not only sports nutrition products, but also sports and energy drinks and bars, were worth US$60bn in 2013 (C. S. Euromonitor International's Consumer Health Analyst, 2014).

Although US is dominating the global market, accounting for over 60% of global sales, the growth is truly global. However, in terms of consumption, developed markets are leading. By way of example, Australia followed by US were leading in consumption in 2013, with an expenditure of US$ 55 and 45 per household respectively; while world average consumption was around US$5 per household. As for low-income markets, despite the barrier of relatively high prices, the global healthy living trend together with the rising disposable incomes, are supporting the increased demand and consumption of sports nutrition products. For this reason, less developed markets such as China, India and Brazil, are evolving and fast growing (C.

S. Euromonitor International's Consumer Health Analyst, 2014), (C. O. Euromonitor International's Consumer Health Analyst, 2017).

Sports nutrition is becoming mainstream

The main reason for the sports nutrition market steady growth is the expansion of its consumer base over the last 10 years (Euromonitor, 2015b). Consumers have an increased health awareness and are increasingly opting for sports nutrition products to complement their work-out sessions (Mordor Intelligence, 2018). As a result, the demand for sports nutrition category and its sales are rocketing.

Sports nutrition products, which are aimed to improve performance, post workout recovery and muscle maintenance and building, were originally designed for elite athletes and body builders in order to keep up with their unique nutritional demands. However, as a result of the healthy living trend, sports nutrition products have become mainstream over the past decade (C. S. Euromonitor International's Consumer Health Analyst, 2014). Besides the constantly increasing fitness clubs, which are exposing more and more recreational sports enthusiasts to sports nutrition products, other key features to support market growth have been innovation, with a growth rate of 10'4% of global product launches between 2011 and 2016, and consumer loyalty. In contrast to what happens to other categories, when users detect a positive difference in performance, they generally stick to it. Thereby, sports nutrition products enjoy a high degree of loyalty (Mordor Intelligence, 2018).

When it comes to consumers, they are not only increasing in number, but also in diversity. As a consequence, knowledgeable and high-volume users who purchase frequently, also known as "core users", no longer dominate sports nutrition sales. In the last decade, sports nutrition products have become more appealing to a greater number of mainstream consumers, often referred to as "casual users", who are recreationally active. They prefer convenient formats and recognizable ingredients (Euromonitor, 2015b). Another group has recently emerged in developed markets, they are the "lifestyle users" who are not particularly athletic but put a greater focus on increasing their fitness levels by trying to do more exercise. Lifestyle users are mainly young and invest in fitness as a fundament aspect of a healthy lifestyle. They are

keen on trying new products, formats and ingredients (C. S. Euromonitor International's Consumer Health Analyst, 2014), (Mordor Intelligence, 2018).

Despite the different characteristics defining each consumer type, what all of them have in common is that they seek transparency, as well as clean and open label formulations (Kang & Hustvedt, 2014). Responding to these demands, third-party banned-substance-free certification has become a standard for major brands and producers. In addition, an increasing number of brands are opening up their proprietary blends with complete ingredient break-outs (C. S. Euromonitor International's Consumer Health Analyst, 2014). In general, a greater focus is put on the presentation of products, including appealing and interactive labelling to make it easier for the consumer to understand the ingredients, and to ensure product safety (Mordor Intelligence, 2018).

Finally, as a consequence of the consumer base expansion and segmentation, sports nutrition products are consumed for different purposes. For this reason, companies are discussing whether a better name for the industry would be lifestyle nutrition or active nutrition, which would appeal to more consumers, helping to continue broadening the consumer base (C. O. Euromonitor International's Consumer Health Analyst, 2017). In line with this last objective, major brands are penetrating mainstream distribution channels, such as gyms, pharmacies and supermarkets. For this reason, products that were once only available in dedicated fitness shops, have made their way to other retailers. In addition, sports nutrition products are also distributed by online sellers, accounting for 41,3% of sales in the US in 2017 (Mordor Intelligence, 2018).

Proteins will not abdicate – and continue leading

Proteins dominate global sales, in no small part as a consequence of being the most accessible and understandable sports nutrition ingredient. While non-protein products were worth US$1,6bn in 2013, this is 17% of the total sports nutrition market; protein products, including powder, bars, ready-to-drink beverages and others, have been growing at a steady pace, reaching US$7,3bn in 2013 and US$9,2bn in 2015, accounting for more than 83% of the total sports nutrition market. In addition, 6,5% compound annual

591 growth is forecasted for protein products during the time frame between 2015 and 2020. In fact, protein
592 market is expected to reach US$13,5bn in 2020 (C. S. Euromonitor International's Consumer Health
593 Analyst, 2014), (Euromonitor, 2015b).
594
595 Protein claims related to muscle mass growth, lean muscle maintenance and recovery from resistance
596 exercise, makes protein the most demanded product on sports nutrition category. Protein is especially
597 appealing for younger consumers, aged 15-34. Its popularity benefits from media praise and still has room
598 to grow, particularly in emergent markets such as China, Latin America and India. Other lesser known
599 protein benefits are satiety, bone and heart health, and antiaging, which are perfectly aligned with global
600 concerns about overweight, obesity, cardiovascular health and aging. Provided that these claims become
601 mainstream, proteins will potentially appeal to millions more in the near future (Euromonitor, 2016). As a
602 result of its reputation as a health-promoting ingredient, natural-containing protein products and protein
603 fortified foods, are also gaining popularity among mainstream consumers.
604
605 In the sports nutrition category, protein products remain the most demanded, as they offer a convenient
606 way of meeting increased protein requirements without excess calories, fats or sugars. When it comes to
607 the format, protein powder accounted for 70-80% of total protein products and reached US$5,6bn in 2013.
608 However, convenience formats, like ready-to-drink beverages, or protein bars, are growing quickly and
609 reached US$ 766mn and 837mn, respectively, in 2013 (Euromonitor, 2016).
610
611 - *Whey protein – a sales king that is being challenged*
612 Among protein powder products, which usually need to be mixed with water or milk, whey is the king of
613 sales. Casein, egg and soy proteins are also fairly common (Euromonitor, 2015b), (Euromonitor, 2016).
614 However, in nutritional terms, whey is one of the best quality protein sources, and it delivers a greater taste
615 than the offered by other sources. Besides its content in essential amino acids and BCAA, whey proteins
616 are also well-known for its easy digestion and quick absorption, which ensure a fast delivery of the building
617 blocks required for lean muscle mass growth and recovery (Hoffman & Falvo, 2004), (Patel, 2015). In fact,

published scientific research has demonstrated that in relation to other protein sources, whey protein promotes greater muscle-building activity and muscle mass gains (Hoffman & Falvo, 2004).

For a long time, whey protein isolate was only popular among core users, but due to a trickle-down effect, its consumer appeal is widening (C. S. Euromonitor International's Consumer Health Analyst, 2014). In addition, whey protein is versatile and easy to use in product applications, so it is also popular among manufacturers (Agarwal, Beausire, Patel, & Patel, 2015). However, as casual and less-sophisticated users increasingly opt for whey protein products, core users are shifting to sustained-release protein blends, which could also gain mass acceptance in the near future (C. S. Euromonitor International's Consumer Health Analyst, 2014). These new formulations, including mixtures of different protein sources and protein treatments (concentrate, isolate and hydrolysate), are challenging whey protein isolate as king of protein sales (Euromonitor, 2016). Other factors, such as sustainability and animal welfare, are increasing the demand for plant-based proteins and therefore, increasing the challenge for whey protein (Radnitz et al., 2015), (Hancox, 2018).

Last but not least, in line with the healthy nutrition trend, high-protein and added-protein foods, which are already in full-swing, could pose a long-term threat to specialized sports protein products; especially among casual and lifestyle users (Chittock, 2013). In addition, although scientific evidence confirms protein supplementation safety, some dietitians are questioning the need and safety of protein supplementation, posing another threat to sports protein products (Antonio et al., 2016).

- *Rising demand for plant-based proteins*

With over 80% of sports nutrition sales coming from protein-based products, and a global high-protein diet trend, sports protein products will continue to lead the industry (C. O. Euromonitor International's Consumer Health Analyst, 2017). However, consumers are increasingly asking for free-from, non-allergenic and plant-based products; and proteins are not the exception. With 3% of US population eating a strictly vegetarian diet, and 36% opting for at least vegetarian meals on a regular basis in 2016, there is a growing demand for plant-based proteins (Vegetarian Resource Group, 2016). Sustainability, animal welfare and a decrease

in reliance on animal-based nutrition are driving the demand for alternatives to milk proteins (C. S. Euromonitor International's Consumer Health Analyst, 2014), (Radnitz et al., 2015), (Hancox, 2018).

Plant-based proteins from soy, pea or rice are less common than whey protein, but they are growing quickly and will continue to do so (Euromonitor, 2016). In fact, scientific evidence shows that plant-based proteins can be as effective as animal proteins for muscle maintenance, as long as the selected source, delivers all the essential amino acids needed (Mangano et al., 2017). In addition, a well-designed vegetarian or vegan diet provides sufficient energy and appropriate range of carbohydrate, fat and protein intakes to support performance and health (Venderley & Campbell, 2006), (Lynch et al., 2016). For this reason, certain elite athletes are going vegan and beginning to consume plant-based proteins, thereby contributing to plant-based proteins consumer base expansion (Edsor, 2017).

- *Hydrolysates are the next big thing – life is too short for slow proteins*

Differences in protein source, amino acid profile, and processing methods, can have an influence on amino acids bioavailability. Hydrolysates are high-quality proteins that have been finely chopped or predigested so that they can be absorbed faster than conventional proteins, helping to cut muscle recovery times from days to hours (Manninen, 2009). For this reason, they play a greater role in those athletes who place higher pressure on their body due to exercise frequency and intensity, and those who have a small window for recovery. Although hydrolysates future is promising, its bitterness and astringency hinders its incorporation into beverages, bars and gels (FitzGerald & O'Cuinn, 2006), (Liu, Jiang, & Peterson, 2014). This is not a drawback for core users, but since casual users prefer convenience products with good taste, until now hydrolysates have had a slow expansion. However, recent advances in hydrolysates processing technology have allowed taste-masking, enabling its incorporation into various formats such as clear drinks (FitzGerald & O'Cuinn, 2006). As a consequence, a fast growth for hydrolysates is forecasted (Euromonitor, 2015b).

<u>What about non-protein products?</u>

Casual users' adoption of non-protein products is growing. However, since these products are more difficult to understand by the mainstream and uninformed consumers, they mostly appeal to core users. With sales

reaching US$160mn in 2013, UK has a leading position in the global non-protein products market. Global sales were worth 1,6bn in 2013 and are expected to grow by nearly US$500mn, achieving US$2bn in 2018 (C. S. Euromonitor International's Consumer Health Analyst, 2014).

In general, fitness-focused lifestyle, a desire for fast results, and a high demand for portable and convenient products, are the main drivers of the sports nutrition category. When it comes to convenience formats, non-protein products have been ahead, leading the experimentation. Gels, chews, bars, sachets and shots are examples of convenience formats. With the rise of endurance sports, gels have become the most popular convenience format (Euromonitor, 2015b), (C. S. Euromonitor International's Consumer Health Analyst, 2014).

As for sports drinks, they are expected to record the highest growth rate in the following years. Sports drinks, including products sold in powder to be rehydrated in water, are highly demanded as consumers become aware of the uses and benefits of drinks rich in carbohydrates, minerals and electrolytes (Zimberoff, 2017). Active and sports people have higher carbohydrate requirements, and without an adequate intake of them, exercise performance decreases (Williams & Rollo, 2015). Electrolyte-replacement, glucose-containing solutions help to maintain blood glucose levels and prevent dehydration and therefore, may delay fatigue and attenuate muscle damage during endurance exercise (American Dietetic Association et al., 2009). However, the growing sugar-averse consumer base is contributing to an increased demand for low-calorie and low-carbohydrate sports drinks, especially in North America, which is the leader in sales (International Food Information Council Foundation, 2018). New sports drinks are mainly focused on optimizing hydration before, during and after physical activity. Maintaining hydration status is one of the most effective ways to maintain exercise performance, which can be significantly impaired when 2% or more of body weight, is lost through sweating (American Dietetic Association et al., 2009),(Ronald J. Maughan & Shirreffs, 2012).

In 2013, sports drinks and energy drinks accounted for US$18,7bn and US$27,6bn, respectively. However, there is a blurring line between energy/sports drinks, and non-protein products category (C. S. Euromonitor

International's Consumer Health Analyst, 2014). The main reason for this, is that energy/sports drinks are shifting from the so-called bad carbs to the good ones. This is translating into products with lesser amounts of ingredients with minimal other nutritional value, like sugar or starches; and with higher amounts of naturally-containing-carbohydrates fruits, vegetables and whole grains (International Food Information Council Foundation, 2018). Strongly aligned with plant-based trend, this new wave of products is blurring the line between energy/sports drinks, and other drinks or beverages in the non-protein products category.

An overview of sports nutrition products' global sales

Before moving forward with other trends to look out for in 2020, Figure 4 shows the global sales of the selected sports foods subcategories in 2013, thus reflecting their relative relevance.

Other trends to look out for in 2020

Nutrient timing is a well-known concept for elite athletes, and casual users' awareness of its importance is increasing. Meal times and snacks should be planned in concert with training, to make sure that athletes have sufficient availability of nutrient-dense foods throughout the day. Research has shown that meal timing and composition may play a role in optimizing performance, training adaptations and preventing overtraining (Kerksick et al., 2008). By way of example, within 30 minutes of a workout, consuming high-quality carbohydrate and protein is key to replenish those nutrients depleted during the workout. While carbohydrates replenish glycogen stores and therefore, support muscle recovery, protein helps in muscle building and repairing (American Dietetic Association et al., 2009).

Global trends such as transparency, clean labeling and personalization are also impacting sports nutrition. Besides those that have already been discussed before, customized workouts and meals, tailored to preferences and goals, will help optimizing physical activity. "One size fits all" will no longer exist, and appeal for personalized fitness plans and nutrition, will broaden from elite athletes to include casual users as well (German, Zivkovic, Dallas, & Smilowitz, 2011), (Nutraingredients, 2016), (Gardiner, 2016).

729 Recovery is gaining importance over rest. While resting is just the absence of training, recovery involves all
730 techniques and activities to maximize repair: hydration, compression, nutrition, heat or cold, stretching and
731 massaging (Menzies et al., 2010). For a long time, a lot of these techniques were only reserved for elite
732 athletes, but casual users' adoption is increasing as they are becoming aware that a balance between rest
733 and recovery, together with a proper nutrition is essential for anyone who exercises (Meltzer, 2018), (Mateo,
734 2018).
735
736 Finally, flavor is one of the most important areas for innovation in the sports nutrition industry, and it has a
737 long way to go in terms of customers acquisition and retention (Cash, 2017). Another main driver of sports
738 nutrition industry is convenience packaging, since consumers prefer small and portable products
739 (Euromonitor, 2015b), (Euromonitor International's Head of Lifestyles Research, 2017).
740
741 Innovation is driving the market – microencapsulation as an example
742 Besides demand-driven innovation, offering technological and professional solutions to mass market
743 consumers is a powerful driver for growth and competitive positioning of a company (PwC, 2013). In this
744 line, technologies such as microencapsulation would allow a broader use of certain ingredients with
745 organoleptic or stability issues, among others. Microencapsulation is a technique that involves the
746 entrapment of a substance within a microscopic shell of encapsulating polymeric material to give
747 microcapsules different useful properties: preventing interactions among ingredients of a formula, flavor
748 masking, increased stability and bioavailability, improved dissolution and flowability, and sustained-release
749 among others (Gaonkar, Vasisht, Khare, & Sobel, 2014).
750
751 By way of example, taste-masking microcapsules allow the incorporation of caffeine into gels or chews
752 without its characteristic bitter taste (Pimparade et al., 2015), (Mohammadi, Ehsani, & Bakhoda, 2018).
753 Other examples of microencapsulation applications are increased water-dispersibility and bioavailability of
754 hydrophobic ingredients, such as coenzyme Q10 or medium chain triglycerides (Gaonkar et al., 2014).
755 Microcapsules are also capable to increase the stability of certain sensitive ingredients, such as probiotics,
756 when they are exposed to different environmental conditions like heat, humidity, light and oxygen (Anal &

Singh, 2007). Furthermore, microcapsules can act as delivery systems. Depending on the microencapsulation technique and wall material selected, the release mechanism can be triggered by different factors such as dissolution, temperature, pressure, pH and enzymes among others; and the release profile can also be modified to be immediate, delayed or sustained (Gaonkar et al., 2014). Finally, microcapsules are also capable to protect acid-sensitive ingredients, like probiotics or enzymes, during their pass through the highly acidic environment of the stomach, and to release them in the intestine, which has an alkaline pH (Anal & Singh, 2007), (Cook, Tzortzis, Charalampopoulos, & Khutoryanskiy, 2012).

Finally, as has just been reviewed, the implementation of professional solutions for mass market products, can help overcome different challenges, from technical issues like shelf-life, to consumer acceptance problems, like unpleasant taste or poor dissolution. Until now, technological advances were a business-to-business tool due to a lack of consumer understanding. However, consumers access to information is greater than ever, and soon they will become aware of the benefits of these techniques (Hamari et al., 2016). For this reason, technological solutions are going to be crucial to differentiate products from their competitors (PwC, 2013).

Considerations on regulation

Last but not least, the sports nutrition category is not only shaped by dietary recommendations and research, but also by regulations. Each country has its own regulation, which has an impact on the direction and growth of the sports nutrition industry. While some countries can select from a wide range of ingredients and claims, other countries may restrict or ban the same ones (R. J. Maughan, Greenhaff, & Hespel, 2011).

The US and the European Union (EU), by their respective competent bodies, Food and Drug Administration (FDA) and European Food Safety Authority (EFSA), have its own composition and labelling requirements, which will be briefly reviewed below. It is important to remark that besides the benefits provided by supplements and sports food, safety remains the main priority (US Congress, 2011). When it comes to professional athletes competing under anti-doping codes, not only evidence and safety are important factors to consider, but also the absence of prohibited substances. For this reason, it is important to highlight

a valuable information resource developed by the Australian Institute of Sport. It consists of an ABCD classification system that ranks those ingredients found in sports foods and supplements, into four groups. It is based on scientific evidence and other practical considerations to stablish product safety, legality and efficacy in improving sports performance (Australian Institute of Sport, 2018).

- *US regulation*

In US, according to the Dietary Supplement Health and Education Act, dietary supplements are defined as products taken by mouth, which are typically sold in the form of capsules, soft gels, liquids, powders and bars, and that contain one or more dietary ingredients intended to supplement the diet. Vitamins, minerals, herbs, botanical extracts, amino acids and other substances may be considered dietary ingredients. Products sold as dietary supplements must be clearly labeled as such. FDA monitors its manufacturing processes, quality and labelling, but it grants a greater control over supplements containing new dietary ingredients. A new dietary ingredient is a dietary ingredient that was not sold in the US before 1994. FDA requires specific safety information from manufacturers intending to market food supplements containing new dietary ingredients. Safety evidence, which may include in vitro and long-term toxicity studies, and clinical studies in humans, must be provided to FDA. When it comes to health and nutrient content claims, efficacy evidence must be submitted to FDA for approval. Authorities can act against companies who make false or misleading claims; and can also remove supplements from the market if they lack sufficient scientific evidence to demonstrate product safety. In addition, companies are now required to record all adverse event complaints about their products; and must report to FDA all those serious adverse events (United States Congress, 1994), (US Food and Drug Administration, 2018).

- *EU regulation*

As for the regulation in Europe, according to European Parliament Directive (2002/46/EC), food supplements are defined as products intended to supplement the normal diet, consisting of concentrated sources of nutrients, like minerals and vitamins, or other substances with a nutritional or physiological effect that are marketed in a “dosage” form (e.g. pills, tablets, capsules or liquids in measured doses). Food supplements are regulated as foods, and thereby may contain vitamins, minerals, amino acids, essential

fatty acids, fiber and various plants and herbal extracts, among others. It has to be noted that the addition of nutrients or other substances to fortify foods, does not fall within the definition of a food supplement, and is addressed by a different regulation. Food supplements are intended to correct nutritional deficiencies, maintain an adequate intake of certain nutrients, or support specific physiological functions. The responsibility for the safety of these products lies with the food business operator placing the product on the market (European Parliament, 2002).

In order to protect consumers against potential health risks, EFSA carried out a comprehensive assessment of substances that could be intended for food supplements manufacture in the EU. Based on EFSA's work, the European Commission established a harmonized list of substances that may be used in the manufacture of food supplements, their tolerable upper intake levels, labelling requirements and approved health claims (European Parliament, 2006b), (European Food Safety Authority, 2006), (European Parliament, 2011), (European Parliament, 2006a). There is also a list of those substances that are known or suspected to have adverse effects on health, and the use of which is therefore controlled. As for those substances intended to be used in food supplements, and that do not have a history of safe use in the EU before 1997, which are known as "novel foods", EFSA is requested to provide a scientific opinion on its safety (European Parliament, 2015).

Finally, the EU register provides information on the permitted nutrition and health claims made on foods, and their conditions of use and applicable restrictions, as well as non-authorized health claims and the reason for their non-authorization (European Commission, 2018).

- *Worldwide anti-doping regulation*

The World Anti-Doping Agency (WADA) is an international independent agency with scientific research, education, development of anti-doping capacities, and monitoring of the world anti-doping code, as key activities. Its mission is to lead a collaborative worldwide movement for doping-free sport, bringing consistency to anti-doping policies and regulations within sport organizations and governments across the world (World Anti-Doping Agency [WADA], 2018a). The list of prohibited substances and methods, which

is updated annually, is a cornerstone of the WADA. It lists substances prohibited at all times, just in-competition or in particular sports. Some examples of prohibited substances are non-approved pharmacological substances, anabolic agents, beta-2 agonists and diuretics, as well as masking agents. Examples of prohibited methods are manipulation of blood, chemical manipulation of samples collected during doping control and gene doping (WADA, 2018b).

According to world anti-doping code, athletes are responsible for all products ingested and any subsequent legal, health or safety consequence (WADA, 2015). For this reason, they should pay special attention when choosing a supplement, since some of them have been reported to have an accidental or deliberate content of banned substances (R. Maughan, 2005). A research of stimulants and anabolic steroids in dietary supplements revealed that the number of mislabeled supplements represented 18% of the 103 products analyzed (Baume, Mahler, Kamber, Mangin, & Saugy, 2006). For this reason, some manufacturers order commercial third-party auditing programs, as an independent screening for banned and restricted substances that could be accidentally found in their dietary supplements. These certifications provide a greater assurance of supplement purity for those athletes competing under antidoping codes (Bishop, 2010). Non-intentional doping poses a threat to athlete's career, since anti-doping rule violation, regardless it was intentional or unintentional, may result in bans of up to four years (WADA, 2015).

Sports nutrition trends in brief

In line with the healthy living global trend, as consumers are increasingly focusing on health and fitness goals, different categories, like wearable devices, are growing. Sports nutrition is the fastest growing consumer health category for several years in a row, and it is expected to continue growing at a steady pace in the following years. An expanding and more diverse consumer base is boosting the demand for sports nutrition, which has become a mainstream category. For this reason, products that were once only available in dedicated fitness shops, have made their way to other retailers.

As for the sports nutrition king ingredient, proteins dominate global sales accounting for more than 83% of total sports nutrition market. Since proteins are the most accessible and understandable sports nutrition

869 category, further growth is forecasted for the next five years. Among protein powders, whey isolate is the
870 preferred source, due to its taste, amino acid composition and quick absorption. However, new formulations
871 including different sources and treatments of proteins, are challenging whey protein isolate as king of sales.
872 The main threats for whey protein isolate are a rising demand for plant-based proteins, and hydrolysates
873 of different protein sources.
874
875 On contrast, non-protein products are more difficult to understand by the mainstream and uninformed
876 consumers, and account for just 17% of total sports nutrition market. Despite not leading in sales, non-
877 protein products are way ahead of convenience formats experimentation. As for sports drinks, they are
878 expected to record the highest growth rate in the following years. Electrolyte-replacement, glucose-
879 containing solutions help to maintain blood glucose levels and prevent dehydration, and therefore, may
880 delay fatigue and attenuate muscle damage during endurance exercise. However, since there is an
881 increasing demand for low-calorie and low-carbohydrate sports drinks, new products are mainly focused
882 on optimizing hydration.
883
884 Besides global trends like clean labeling and personalization, which are impacting sports nutrition, other
885 emerging trends to look out for in 2020 are nutrient timing, recovery gaining importance over rest,
886 convenience packaging, and flavor as one of the main areas for innovation. Finally, offering professional
887 solutions to mass market is key for disruptive innovation. Application of technologies such as
888 microencapsulation in the sports nutrition field, would allow a broader use of certain ingredients with
889 organoleptic or stability issues. In addition, preventing interactions, improving dissolution and achieving a
890 sustained-release profile by means of microencapsulation, could also drive the sports nutrition category.
891
892 Last but not least, when it comes to the direction and growth of the sports nutrition industry, it is shaped by
893 different factors. One of the most relevant but frequently forgotten factors is regulation, which can be
894 different in each country. Competent authorities can restrict or ban ingredients to ensure safety and can
895 also regulate to avoid false or misleading claims. Professional athletes who compete under anti-doping

codes, may only consider certain manufacturers which provide a third-party certificate ensuring that no banned or restricted substance is present.

Conclusion

Global dynamics are shaping consumer attitudes and thereby, promoting changes across industries. Clean and healthy living stands out as the most relevant trend impacting the food industry. Consumers are making informed decisions to prioritize healthy, plant-based, sustainable and socially-conscious food purchases, a trend which is also affecting beverages, snacks, indulgence foods and even fast food. Aligned with this trend, governments are promoting healthy habits to reduce morbidity and cut off its associated costs. In this context, not only vegetarian and vegan product sales are growing quickly, but also organic and free-from products. In addition, since consumers prefer foods with an intrinsic nutritional value, functional foods have been outpaced by naturally healthy products.

Due to media praise and sports nutrition, a category where protein is the king of sales, consumers are increasingly looking for high-protein products. Carbohydrates, instead, have been targeted as a strategy to reduce overall calorie intake, resulting in a decreased popularity. However, the source matters, and “good carbs” are used instead of “bad carbs”. In this line, as consumers increasingly avoid certain food ingredients, clean label products are no longer a trend, but the new norm. Nonetheless, the replacement of certain ingredients may set up costly and sometimes unnecessary challenges for food scientists. Other relevant trends shaping interaction with foods are personalization, IoT, and food waste reduction. However, one of the main trends is sports nutrition, which is a large and quickly growing consumer health category.

Sports nutrition sales are no longer dominated by core users, instead, they have become more appealing to mainstream consumers, and as a result, sports foods have made their way to mainstream distribution channels. Proteins are leading the sports nutrition category, but whey protein isolate, which is the king of sales among protein powder products, is being challenged by the rise of high-protein foods and the rising demand for plant-based proteins. When it comes to protein processing methods, isolates are being replaced by hydrolysates, which are expected to be the next big trend among protein powders. As for non-protein

924 products, despite experiencing a slower growth, they are leading the experimentation in convenience
925 formats. Regarding new sports drinks products, they are mainly focused on optimizing hydration, and
926 shifting from the so-called bad carbs to the good ones. As a consequence, there is a blurring line between
927 energy/sports drinks, and other non-protein drinks or beverages.
928
929 Other trends to look out for in 2020 in the sports food industry are nutrient timing, personalization, recovery
930 gaining importance over rest, and flavor as one of the most important areas for innovation. Different
931 professional technologies can be applied to mass market products, as a driver for growth and competitive
932 positioning. In this context, microencapsulation stands out as one of these technologies with a wide variety
933 of applications and a promising future. Finally, besides innovation, dietary recommendations and research,
934 the sports nutrition category is shaped by regulations; among which stand US and EU regulation, and World
935 Anti-Doping Code.
936
937 To conclude, global dynamics have an influence on nutrition trends, being potentially disruptive for the
938 correct balancing of the diet. However, as it has been reviewed, along with the healthy living trend, more
939 people are adopting an active lifestyle, embracing a healthier dietary pattern and recognizing the benefits
940 of sports foods, which is having positive implications in health, well-being and healthcare-associated costs.
941 This review has also provided an overview of the areas that are more prone to development, and that should
942 be added to the research agenda to adapt formulas and technologies to consumer needs.
943

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952

953 **Abbreviations**

954 AGAUR: Agency for Management of University and Research Grants

955 bn: billion

956 EFSA: European Food Safety Authority

957 EU: European Union

958 FDA: Food and Drug Administration

959 GMO: Genetically Modified Organism

960 IoT: Internet of Things

961 mn: million

962 UK: United Kingdom

963 US: United States of America

964 WADA: World Anti-Doping Agency

965 WHO: World Health Organization

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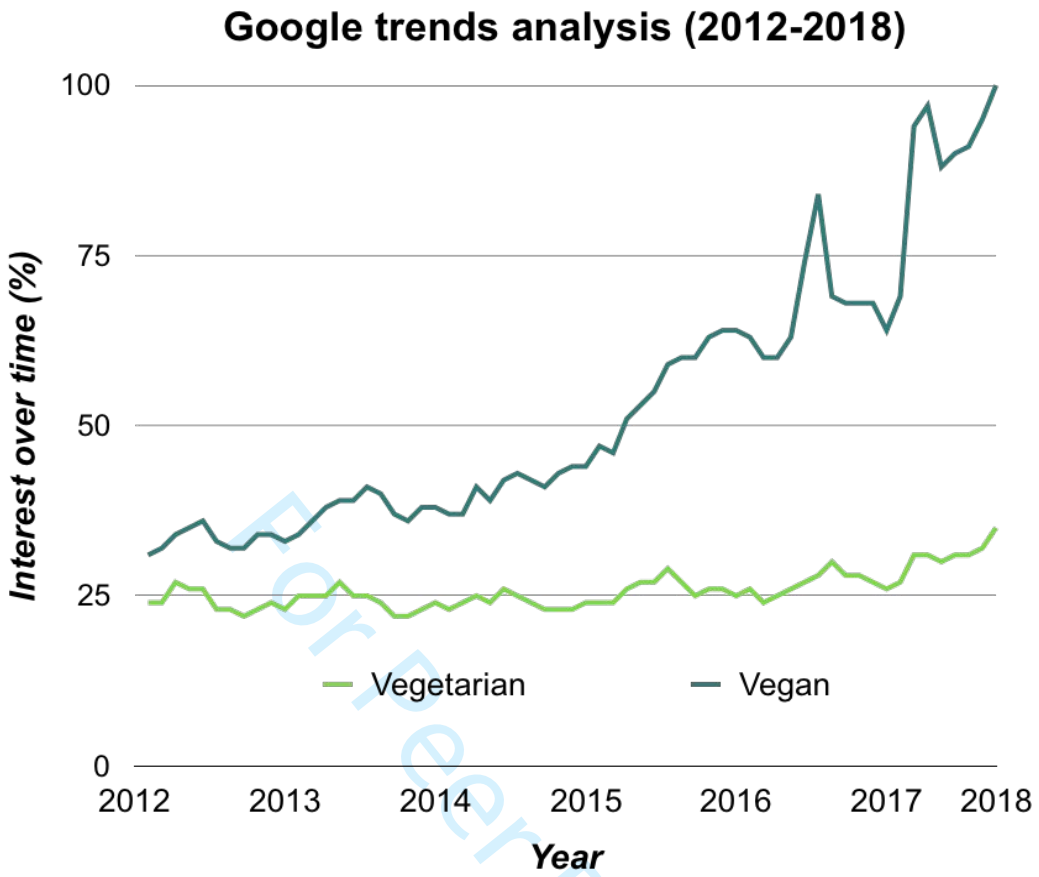

Figure 1. Interest over time of "vegetarian" and "vegan" search terms (Google Trends, 2018).

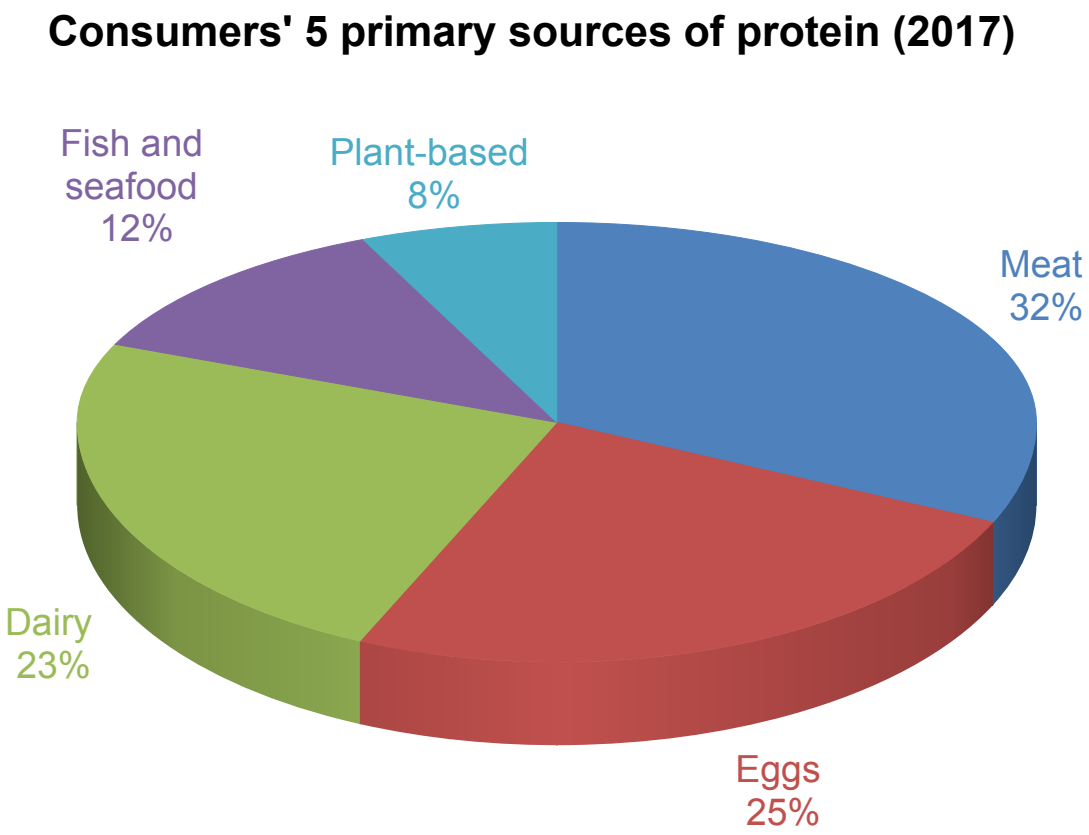

Figure 2. Top five protein sources via consumer survey (The Nielsen Company, 2017).

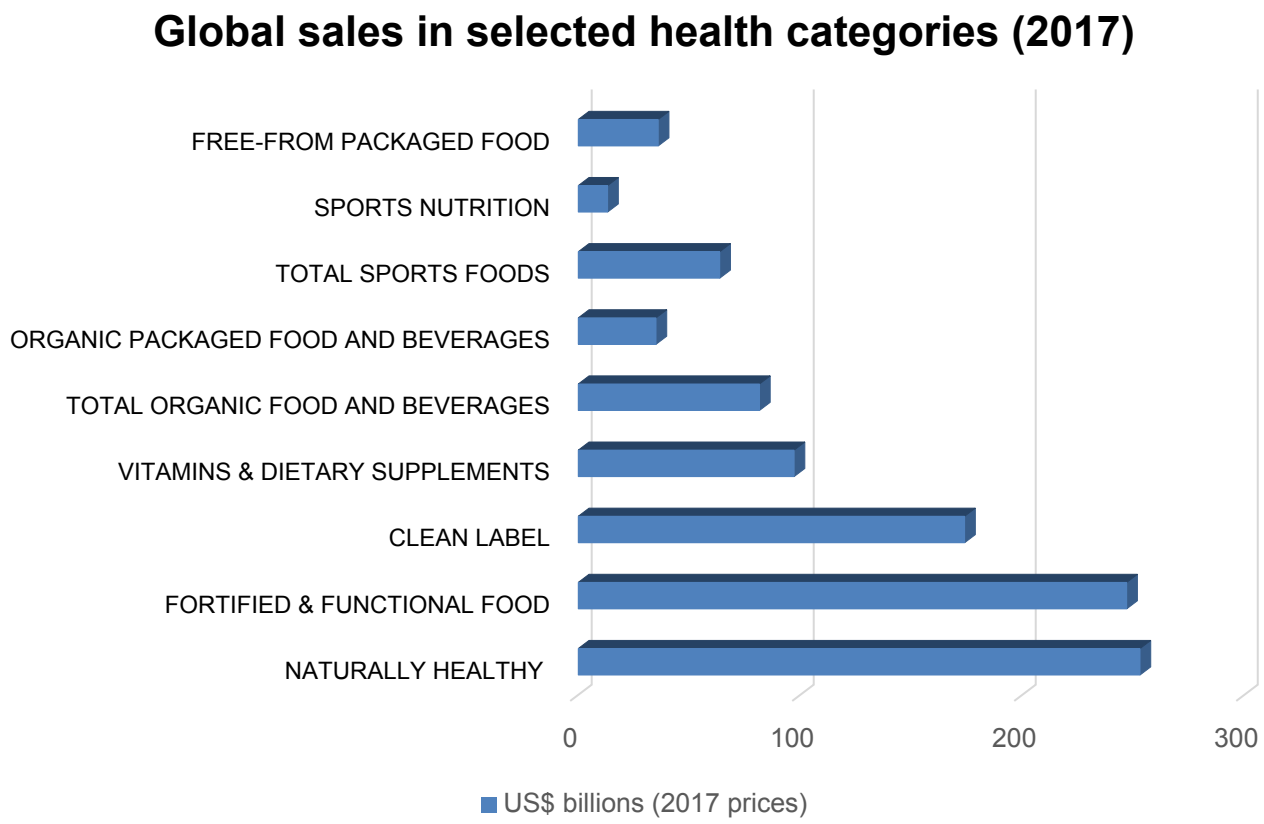

Figure 3.Global sales in selected health categories – 2017 (Euromonitor International's Head of Lifestyles Research, 2017), (Sahota, 2012), (FIBL and IFOAM, 2017), (Euromonitor, 2015a), (Daniells, 2018), (M. M. Euromonitor International's Consumer Health Analyst, 2018), (Bizozzero, 2017), (C. S. Euromonitor International's Consumer Health Analyst, 2014).

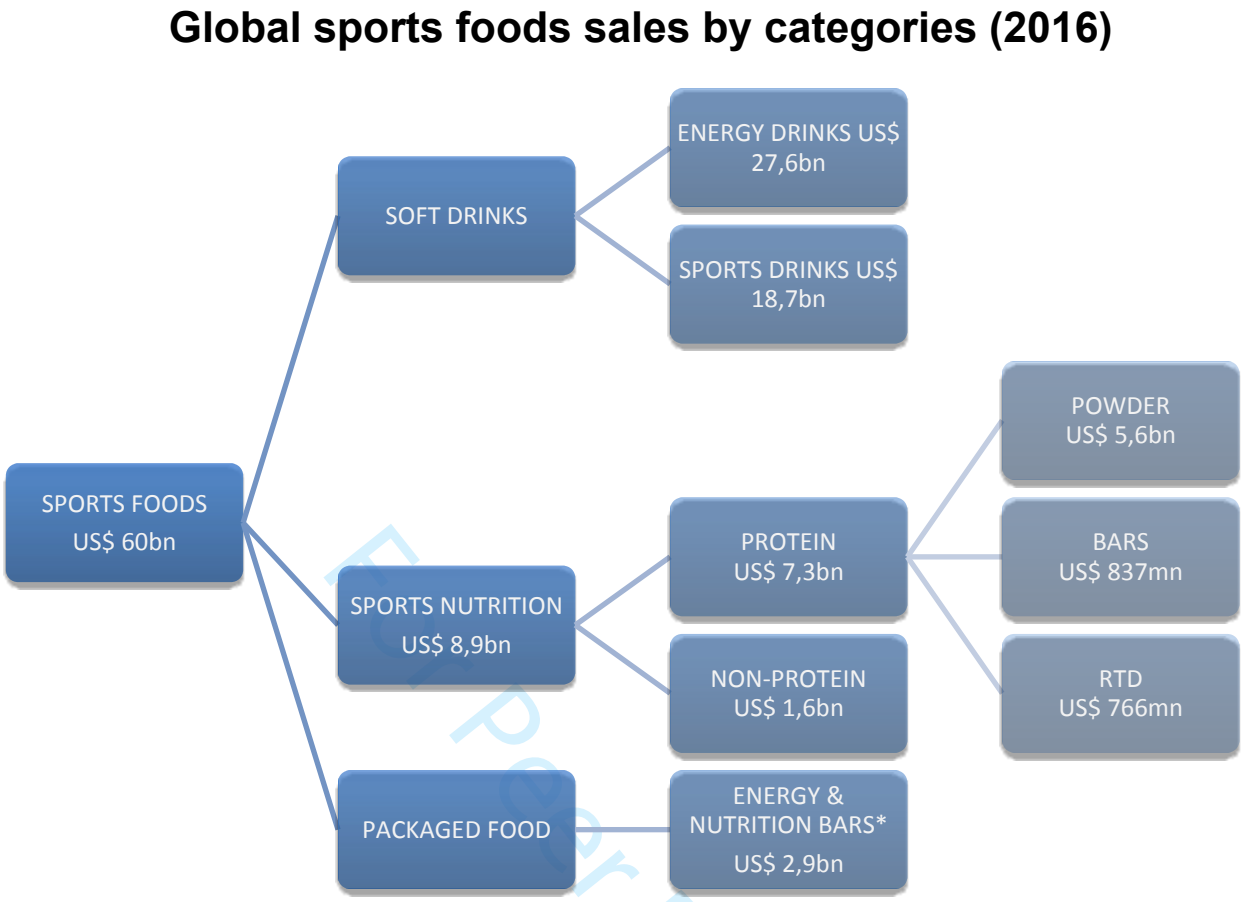

*Figure 4.Global sports foods sales by categories (global retail value, US$ bn, constant 2013 prices). (C. S. Euromonitor International's Consumer Health Analyst, 2014), (Euromonitor, 2015b), (Euromonitor, 2016). * Excluding sports nutrition protein bars.*

Trends in the Food and Sports Nutrition Industry: A Review

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ABSTRACT: This revision intends to provide an overview on the major and emerging trends in food and nutrition. Food scientists and dietitians should keep an eye on the trends shaping the food industry in order to understand consumer changes in preferences, expectations and dietary patterns; and to identify those areas that should be added to the research agenda. In addition, to comprehend the major drivers of change in the food industry, global consumer trends are also reviewed in this article. Global concerns are shaping consumer attitudes, and with an easier access to information and an unprecedented consumer power through social media, the food industry should quickly adapt to meet consumer needs. In order to meet these objectives, this review is organized in three different but interrelated sections: global consumer trends, food and nutrition trends, and trends in sports foods and nutrition. This last one is also included due to its influence over food trends, and its significant relevance as a category and food trend.

Keywords: food trends, food industry, nutrition, sports nutrition, consumer.

Table of contents:

Introduction

The development of new food products is influenced by numerous factors, but among them, global dynamics stand out. Demographics, socioeconomics, culture, politics and environment have a great impact on consumer lifestyles and dietary patterns. In fact, global issues such as climate change, global population aging, child exploitation, food waste, unfair trade or animal abuse, among others, are shaping consumer attitudes towards healthy, plant-based, sustainable and socially conscious food purchases (The Nielsen Company, 2018a). It has to be noted that, thanks to the irruption of new technologies, consumers not only have an easier access to information, but also an unprecedented power to lobby for change (Euromonitor International's Head of Lifestyles Research, 2017).

In this context, and in order to adapt formulas and technologies to consumer needs, food scientists should keep an eye on the major and emerging trends shaping the food industry. Understanding consumer changes in preferences and expectations is vital when developing new products (PriceWaterhouseCoopers [PwC], 2013). Moreover, global dynamics have an influence on nutrition trends, thereby impacting dietary patterns and being potentially disruptive for the correct balancing of the diet. For this reason, not only food scientists, but also dietitians should be aware of the emerging trends that will influence food and nutrition in the coming decades.

The aim of this review is to provide an overview of the current food trends, identifying the areas that are more prone to development, and thus, that should be added to the research agenda. In addition, due to its influence over food trends, and its relevance as a category and food trend, sports foods and nutrition are also reviewed in detail (European Specialist Sports Nutrition Alliance [ESSNA], 2018), (Euromonitor, 2015b). Global consumer trends are also addressed in this review in order to understand the major drivers of change in the food industry. Finally, this review is organized in three different but interrelated sections: global consumer trends, food and nutrition trends, and trends in sports foods and nutrition.

Global Consumer Trends

In 2018, with a stronger global economy, consumer expenditure is expected to grow as its strongest rate since 2011 (Euromonitor International's Head of Lifestyles Research, 2017). However, shifting consumer attitudes will continue shaping changes in business.

Clean-living and activist consumers

Consumers are becoming activists due to an increased awareness of global issues through Internet and social media; which at the same time give consumers an unprecedented power to lobby for change (Labrecque, vor dem Esche, Mathwick, & Novak, 2013). Consumer opinions are far-reaching, and they feel that their spending choices can make a difference (Labrecque et al., 2013). Concerns about climate change and health are widespread among consumers, especially the younger who are adopting a clean-living lifestyle. Clean lifers have strong beliefs and ideals, and they are embracing a minimalist, balanced and healthier lifestyle to reduce harm to themselves, others and the environment (Euromonitor International's Head of Lifestyles Research, 2017). Furthermore, they are demanding companies a greater transparency, sustainability and social responsibility (Kearney, 2010), (Kang & Hustvedt, 2014).

Personalization, a trend across all industries

Besides going greener, consumers are seeking uniqueness, demanding to be involved in the production process and product personalization (Wind & Rangaswamy, 2001). Although customization is demanded in all industries, from sneakers and furniture, to services and experiences; there is a rising interest in personalized health and beauty (Euromonitor International's Head of Lifestyles Research, 2017). Genetic findings related to health, fitness and nutrition, as well as a rising interest in health, and a growing consumer curiosity about their genetics, are fueling demand for DNA testing (Subbiah, 2007), (Ferguson, 2013).

Informed and connected consumers are shaping changes

Millennials, also known as "the connected generation", are driving the consumer revolution. Mobile devices are nowadays vital for everything, including shopping, sharing experiences, or health and sport tracking among others (Deloitte, 2013). Health technologies, including wearables and fitness apps, have made

people more aware of their state of health, powering the growth of health and wellness market (L. G. Euromonitor International's Consumer Health Analyst, 2016). In fact, people tend to exercise more, with gym memberships in the United States of America (US) increasing by more than 20% for the period comprised between 2011 and 2016 (Business Development Bank of Canada [BDC], 2016).

Thanks to new technologies, consumers are more informed about their choices and reject unmeasured or uninformed spending. Ownership is under question and sharing is gaining popularity (Hamari, Sjöklint, & Ukkonen, 2016). A new wave of apps aims to provide consumers with the opportunity to share everything, from cars to living spaces (The Economist, 2013). Consumers prefer spending their money on experiences like travels, festivals and restaurants, rather than on products (Euromonitor International's Head of Lifestyles Research, 2017). Buying time, such as adopting online shopping and ordering food for delivery, is also a trend on the rise (L. G. Euromonitor International's Consumer Health Analyst, 2016). For this reason, an increased growth rate in apps and mobile optimized websites is forecasted.

Global consumer trends in brief

Thanks to the irruption of new technologies, consumers' opinion is more powerful than it has ever been. For this reason, concerns about climate change, health and social responsibility, which are widespread among consumers, may shape changes in business. Other important trends are personalization and shared economy; as well as seeking for experiences or saving time rather than buying products. Finally, millennials will lead the mobile-driven market transformation, as they expect to do everything by using their mobile phone.

Food and Nutrition Trends

Global trends have the power to transform and disrupt entire categories, such as nutrition. One of the aforementioned global trends, clean/healthy living, stands out as the most relevant trend impacting the food industry. Connected and informed consumers are going back to nature and unprocessed foods, to preserve most of the natural vitamins and minerals. For this reason, there's a growth in plant-based, organic, naturally healthy and "free-from" foods. Clean label is also a trend on the rise, and while healthy snacks and fats are

coming back, sugar and certain carbohydrates are becoming the main enemies. Protein, instead, is the preferred food component. Other trends such as personalization, redefinition of indulgence foods, activist consumers, and Internet of Things (IoT), are shaping changes in consumer behaviors and therefore, in the food industry. However, the most relevant nutrition trend is the rise of sports nutrition category.

Older population growth – increased focus on health care

As both the proportion of older people and the average life expectancy increase throughout the world, the older population is growing dramatically worldwide; and therefore, the incidence of chronic diseases (Global Burden of Disease Study 2013 collaborators, 2015). In fact, in about five years' time, the number of people aged 65 or older, will outnumber children under age 5; representing a forecasted 16% of world's population by 2050 (World Health Organization [WHO], 2015b). Population aging is placing pressure on overall health care spending in developed countries, and for this reason, governments are interested in promoting healthy habits to reduce morbidity and cut off its associated health-care costs. In this spirit, the World Health Organization (WHO) released "Active ageing: a policy framework" in 2002 to prevent and delay chronic diseases and premature mortality, as well as their risk factors (WHO, 2015a).

In line with WHO's health action plan, and thanks to consumer connectivity and access to information, there is an increased attention on health care (Kearney, 2010). For this reason, by 2020, a double-digit growth has been predicted for health and wellness market in the US. In addition, an increasingly number of consumers are seeing food as a medicine, and as a consequence, dietary supplements and sports nutrition stand out as one of the fastest growing healthcare categories, with an expected growth of 14% over the next few years in the US (BDC, 2016).

Connected consumers, informed decisions: going greener and healthier

With an easier access to information, consumers are becoming more aware than ever of ingredients in their food and their properties. In order to make informed decisions, consumers seek transparency throughout the production process to understand what is in their food and how it was produced (Bjørndal, Fernandez-Polanco, Lappo, & Lem, 2013), (Kang & Hustvedt, 2014). Clean lifers are turning their backs on unhealthy

habits, food waste and animal-based products. They want to feel good about their consumption choices by eating healthily, sustainably and ethically (Radnitz, Beezhold, & DiMatteo, 2015). Nowadays, eating often carries an ideological charge similar to belonging to a political party or football club (Euromonitor, 2015a). In fact, in 2018, 67% of US consumers said that they will be prioritizing healthy or socially conscious food purchases (The Nielsen Company, 2018a). Even fast food is getting greener, and there is a decrease in reliance on animal-based nutrition. The vegetarian and vegan movement are already in full-swing, and on the next years we will see a further push to eradicate or reduce animal-based products (Hancox, 2018), (Radnitz et al., 2015).

- *Vegetarian and vegan diets on the rise*

The proportion of individuals choosing to follow a vegan diet has increased in the recent years, with ethics and health being the main reason for such choice (Radnitz et al., 2015). As a result of consumer interest, vegan sales growth is outpacing total food and beverage sales (The Nielsen Company, 2018b). When it comes to health benefits of vegetarian eating, current scientific evidence reinforces benefits of a plant-based diet that is low in fat, added sugars, added salt, and processed foods. A healthy and well-planned vegan diet, with a high content of fruits, vegetables and wholes grains, can provide sufficient energy and an appropriate range of carbohydrate, fat and protein intakes to support performance and health (Venderley & Campbell, 2006). In fact, many top athletes, including world champions like Venus Williams and Lewis Hamilton, are vegan, thereby contributing to a vegan consumer base expansion (Edsor, 2017).

In line with this growing consumer interest, global market for vegetarian and vegan products was worth US$51bn in 2016, but it is still expanding, with a 987% increase in demand for vegetarian products (The Vegan Society, 2018). In the same year, a 3% of the US population ate a strictly vegetarian diet, and about half of those were vegan. But the biggest revelation was that 36% of consumers opted for at least some vegetarian meal on a regular basis (Vegetarian Resource Group, 2016). In the United Kingdom (UK), the number of vegans quadrupled in the years between 2014 and 2018, reaching a 1,16% of the population (The Vegan Society, 2018). Indeed, as shown in Figure 1, vegan trend tripled in the years between 2012 and 2018 (Google Trends, 2018). In line with this rapidly growing consumer demand for vegetarian and

vegan products, big companies such as Danone, McDonald's or Ben&Jerry's have invested in vegan alternatives to their products (The Vegan Society, 2018).

To sum up, consumers are keener on more plant-based, natural, minimally processed, local and seasonal food. According to Euromonitor International Global consumer trends survey 2017, "all natural" is the preferred food attribute, followed by "no artificial sweeteners", "limited or no added sugar" and "does not contain Genetically Modified Organisms (GMO) ingredients". In line with these findings, the following categories are on the rise (Euromonitor, 2017a).

- *Organic food growth*

Consumers are moving towards products perceived as more natural and healthier, resulting in a global demand for organic products (Asioli et al., 2017). Global sales of organic food and drink expanded by about 10% to US$81,6bn in 2015. The highest growth was observed in North America, which has the largest market for organic food and drink in the world. Valued at US$43,4bn and accounting for over half of international sales, it is followed by the European market, which is valued at US$31,1bn in 2015. Asia, Australasia and other regions, account for just US$7,2bn in 2015. Despite having had an enormous growth, from US$18 to 82bn over 15 years, organic food drink and sales growth is expected to continue (Sahota, 2012), (FIBL and IFOAM, 2017). In fact, by 2019, 30% growth is forecasted for organic beverages in Canada (BDC, 2016).

When it comes to the organic packaged food and beverages, in 2016 they had a global retail value RSP of US$32,153mn and US$3,972.7mn, respectively (Euromonitor, 2015a). And in 2018, in Latin America, organic and "free-from" packaged food, are worth US$35bn and US$36bn; and will have annual growth rates of about 6% and 3,5%, respectively, thereby standing out as one of the food categories with a global strongest growth (Daniells, 2018).

- *"Free-from" and digestive wellness*

Specific ingredients and even entire categories or food groups, such as dairy, lactose, sugar, sodium, gluten, meat, fats and carbohydrates, are being avoided or limited by an increasing number of consumers (International Food Information Council Foundation, 2018). 68% of US consumers are concerned with what is not in their food (The Nielsen Company, 2018a), and those who avoided at least five separate ingredients increased from 35% in 2015, to 53% in 2016 (L. G. Euromonitor International's Consumer Health Analyst, 2016).

In the same year, global free-from foods were valued at US$33bn, and have consolidated as the category with the most dynamic growth in the health and wellness market (Euromonitor, 2017b). Consumers perceive "free-from" offering as healthier, and they associate it to digestive wellness and gut health. For this reason, free-from trend has gone beyond intolerance and allergies, as consumers increasingly focus on foods that may help them to reduce feelings of gas, bloating or more severe gastrointestinal symptoms related to suspected allergies or intolerances (Mintel, 2016), (Kerry Health And Nutrition Institute [KHNI], 2018). As a consequence, "free-from" products, as well as added-benefit ingredients such as probiotics and prebiotics are on the rise. When it comes to the largest subcategory, free-from dairy is leading, due to an increased demand for dairy milk alternatives. It is followed by free-from gluten, which had the largest absolute growth over the period between 2012 and 2017 (Euromonitor, 2017b). In fact, in 2015, 12% of new food products launched in the UK carried a gluten-free claim (Mintel, 2016).

- *Naturally healthy vs. fortified and functional food*

Functional foods are those containing added biologically active ingredients that may improve health or lower the risk of disease. Besides supplying macronutrients, vitamins and minerals, they may include other active ingredients like antioxidants, prebiotics, probiotics, enzymes and/or phytonutrients to deliver a specific health benefit above their basic nutritional value (Bigliardi & Galati, 2013).

Functional food term encompasses a wide variety of products, like those enriched or fortified. Enrichment involves replacing those nutrients lost during processing. An example is bread, often enriched with iron and

286 folic acid, which are removed during milling of wheat to make flour (WHO, 2018), (Overview of Food
287 Fortification, 2003). Fortification, instead, involves adding nutrients irrespective of whether they were
288 originally present to any great extent in the food. Fortification is mostly used to improve nutritional status of
289 a population or to differentiate products providing a competitive advantage. For example, bread may be
290 fortified with omega-3 fatty acids (Gökmen et al., 2011). Nutrients are also usually added to substitute
291 products in order to achieve a similar nutritive value to that in the original product. An example is the addition
292 of calcium to soya-based drinks, which are sold as cow's milk substitute, in an amount equal to milk's
293 natural content (Yazici, Alvarez, Mangino, & Hansen, 1997).
294
295 On the other hand, naturally healthy products are those that naturally contain active ingredients. An
296 example is oatmeal, which contains a soluble fiber that can help lower cholesterol levels and heart disease
297 risk (Othman, Moghadasian, & Jones, 2011), (Bernstein et al., 2013). In line with the clean-living trend,
298 more consumers like the idea of whole plant-based foods with intrinsic nutritional value, and thus, without
299 the need for fortification. This is leading to a decrease in demand for functional foods. In fact, naturally
300 healthy, valued at US$253bn, has already outpaced global fortified and functional food and beverage
301 market, which is valued at US$247bn (M. M. Euromonitor International's Consumer Health Analyst, 2018).
302 Despite functional food category growth slowing down, this category is still expanding and important,
303 especially in emerging markets, where consumers are seeking functional ingredients linked to a health
304 positioning (Kearney, 2010).
305
306 Clean label, no longer a trend but the new norm
307 "Clean label" concept doesn't have any commonly accepted definition, and it is more based on consumer
308 perception rather than on scientific evidence. Clean label products are those made with ingredients that
309 consumers recognize and trust, and that do not contain undesirable ingredients (Asioli et al., 2017),
310 (Bizozzero, 2017). Clean labeling usually involves reducing the number of ingredients, particularly those
311 perceived to be artificial, and those lacking any nutritional benefit. Mainly focused on removing food
312 additives, such as synthetic colors, preservatives, stabilizers, emulsifiers and texturizers; clean labelling in
313 its purest form also involves reducing certain food components such as fat, sugar and salt among others.

Claims such as “all natural”, “no artificial sweeteners”, “limited or no added sugar”, “non-GMO” and “minimally processed” are often included in clean label products (Asioli et al., 2017).

In line with the aforementioned global trends, consumers are increasingly mindful of their food and beverage choices. 69% and 52% of worldwide consumers believe, respectively, that products without artificial ingredients, and products with fewer ingredients, are healthier (The Nielsen Company, 2016). For this reason, consumers are willing to pay more for clean label products, whose global sales hit US$165bn in 2015 and are projected to reach US$180bn by 2020 (Bizozzero, 2017).

Clean label products are no longer a trend but the new norm (Bizozzero, 2017). Ingredient names, and especially consumer familiarity and acceptance of them, play a central role in clean-label. Long, chemical-sounding, difficult-to-pronounce or unfamiliar names lead to perceptions of higher risk and raise questions about the reason for their use in foods (Asioli et al., 2017). Therefore, clean labeling often includes swapping chemical-sounding names for consumer-friendly ones. By way of example “tocopherol”, a synonym of vitamin E, might be perceived as chemical or artificial, so it would be better to list it as vitamin E. However, going clean label is not always such an easy task (Gallagher, Gormley, & Arendt, 2004). For this reason, the replacement of ingredients regarded as redundant, unacceptable or even harmful without any scientific justification sets up costly and sometimes unnecessary challenges. In addition, as previously mentioned, clean labeling is more about consumer perception than scientific evidence. With a constantly changing consumers’ wish-list, so does the target for formulators, whom at the same time have to face functionality, quality and safety issues derived from the replacement of certain ingredients (Lamacchia et al., 2014).

Protein is king, fat is back, and what about carbohydrates?

While consumers try to avoid specific ingredients, others are on the rise. Consumers are increasingly looking for high-protein foods, since an optimal protein intake is usually associated with satiety and lean body mass gain or maintenance (Euromonitor, 2016). Protein also serves as a great replacement for sugar and fat, which are usually linked to an unhealthy diet (Lucca & Tepper, 1994). With 55% of US consumers considering high protein content a remarkable attribute when buying food products, protein demand is

increasing (The Nielsen Company, 2017). However, it still has room to grow, especially in emergent markets.

When it comes to the reasons for this protein surge, media praise and sports nutrition have a lot to do with it. Protein dominates sports nutrition global sales, as it is an accessible and understandable ingredient, which gives multiple health benefits (C. S. Euromonitor International's Consumer Health Analyst, 2014). It appeals mainly to younger consumers aligned with fitness trends, but with an increasing evidence of benefits on aging, bone and heart health, it will potentially appeal to millions more in the near future (Euromonitor, 2016).

As for the sources of protein, skinless chicken, fish, egg white and lean beef are the best dietary sources of low fat and high-quality protein (Hoffman & Falvo, 2004). While traditional sources like meat, eggs and dairy are consumer's primary sources of protein and still dominate sales (as illustrated in Figure 2), plant-based alternatives are experiencing a strong growth, in demand for health, sustainability and animal rights (The Nielsen Company, 2017).

It should be pointed out that fat, which is usually associated to an unhealthy diet, is an essential component of all cells, and along with carbohydrates, provides the majority of energy to individuals who exercise at a low-to-moderate intensity (Melzer, 2011). "Fat is back" is a trend in agreement with the dietary recommendation that the type is more important than the amount of fat (KHNI, 2018). Certain fats such as polyunsaturated omega-3 fatty acids found in fish and other foods, have a number of reported positive health effects, like mitigating inflammation (Calder, 2010). Other examples of healthy fat's sources would be olive and avocado, which are rich in monounsaturated fatty acids (Owen et al., 2000), (Dreher & Davenport, 2013). Finally, fats also have a technological function, serving as texturizers or as a way to add flavor. The last one is gaining relevance as a result of an increased focus on sugar reduction (KHNI, 2018).

Last but not least, there is a growing concern about the source and content of carbohydrates. They have been targeted by many weight-loss diets as a strategy to reduce overall calorie intake, resulting in a rising

popularity of carb-free foods (International Food Information Council Foundation, 2018). When it comes to its source, minimally refined grains and faux grains like quinoa, amaranth or wild rice, are gaining popularity due to their nutritional profile with increased protein content and a low glycemic index (Peters, 2018). In contrast, consumers try to avoid sugars or starches, which are often referred to as “bad carbs” due to their minimal nutritional value. This is strongly linked with the plant-based food trend, as carbs derived from fruits or vegetables are considered as “good carbs”, and are used instead of refined starches (KHNI, 2018).

Beverages, snacks and indulgence foods redefined

Due to the aforementioned scientific evidence against added sugars and energy drinks, beverages are in a redefinition phase. Functional beverages like kombucha and protein shakes are gaining popularity among consumers, who are keener on beverages that incorporate protein, fiber and vegetable servings, while maintaining an acceptable flavor (KHNI, 2018). In functional beverages, stevia is usually the sweetener of choice for people who want to cut down sugar or calories (Lemus-Mondaca, Vega-Gálvez, Zura-Bravo, & Ah-Hen, 2012).

When it comes to snacks and indulgence foods, they are being reformulated so that they contain more plant-based and/or perceived as healthy ingredients. In addition, due to busier lifestyles, an increasing number of consumers prefer a snackable meal format, which is more convenient than sit-down meals. This is a growing food trend, known as “snackification” (KHNI, 2018).

Activist consumers against food waste

With half of the world’s food being thrown away, there is an increased concern about food waste (McCarthy & Liu, 2017). For this reason, consumer acceptance of “non-perfect” products will grow, and consumers will begin to consider cheap food past its best before date. A revival in use of leftovers, right-size portioning and grow-it-yourself, is also forecasted (Euromonitor, 2015a). Finally, as consumers are keener on new initiatives encouraging more sustainable production and targeting food waste, governments are also making a move. In fact, in France, a law was approved to make supermarkets give food waste to charity or as animal feed (Sénate Français, 2016).

Personalization, a global trend impacting nutrition

As discussed above, personalization is one of the main global trends, which is also influencing nutrition trends. A new wave of companies provides consumers with genetic and metabolomic findings related to their health, fitness and nutrition (Subbiah, 2007). Additional information can be collected through wearable fitness trackers, among other methods; giving an overall picture of health. Personalized training and nutrition plans are offered based on findings of individual parameters such as fat burning ability or capacity to metabolize caffeine, lactose or gluten, among others (Mutch, Wahli, & Williamson, 2005), (Ferguson, 2013). In this context, one of the main challenges of personalization is not just customizing mass-produced products, but also shaping them to individual preferences before production, in order to shift from product to experience or service (Wind & Rangaswamy, 2001), (Euromonitor International's Head of Lifestyles Research, 2017).

Internet of Things shaping interaction with food

By the year 2020, about 24 billion internet-connected devices will be installed globally, which is the equivalent of about 3 devices/person (Gubbi, Buyya, Marusic, & Palaniswami, 2013). IoT may continue shaping the way we purchase, receive and interact with our food. In fact, there is a continued expansion of online or online/offline hybrid subscription services, such as click and collect grocery shopping and delivery of restaurant meals. Due to strong growth of these alternative businesses, it is expected that by 2021, supermarkets and hypermarkets will account for less than a half of the total consumer goods trade (Euromonitor, 2018).

Sports nutrition is rocketing

In line with the aforementioned healthy living trend, more people are adopting an active lifestyle, which is translating into a rise of sport and endurance activities (C. S. Euromonitor International's Consumer Health Analyst, 2014). As scientific evidence confirms that certain ingredients can enhance athletic performance, more people recognize the benefits of sports nutrition products, and therefore, are increasingly complementing their work-out sessions with these products (American Dietetic Association et al., 2009),

(Ronald J. Maughan & Shirreffs, 2012). For a long time, sports nutrition products were primarily meant and used by the so-called core users, that is, elite athletes and bodybuilders. However, the growing health consciousness and desire for fast results has helped sports nutrition to become more appealing to mainstream consumers and thereby, to expand its consumer base over the last decade. The so-called casual users have pushed the category into the mass market (Euromonitor, 2015b). For this reason, products that were once only available in fitness shops, can now be found in pharmacies and even supermarkets, achieving greater total sales for the sports nutrition category (Spano & Antonio, 2008).

Sports nutrition was valued at US$8,8bn in 2013; and sports foods comprising protein supplements, sports nutrition, and soft drinks including energy and sports drinks, were valued at US$60bn in the same year (C. S. Euromonitor International's Consumer Health Analyst, 2014). Despite having experienced a steady rate growth in the last decade, several market researches continue forecasting a sustained global growth for sports nutrition category in the following years (Euromonitor, 2015b). Last but not least, although it has been reviewed as a nutrition trend, sports nutrition is also a category itself, with its own wide range of specific trends, and for this reason it will be reviewed in detail in the corresponding section below.

Nutrition trends in brief

To sum up, global trends and concerns about climate change, health and social responsibility, which are widespread among consumers, are shaping changes in nutrition. As a consequence of the clean-living trend and the older population growth, there is an increased focus on healthy nutrition and physical exercise to prevent and delay aging, chronic diseases and premature mortality, as well as their risk factors.

Consumers seek transparency, and with an easier access to information, they are becoming more aware than ever of ingredients in their food. Consumption choices are influenced by the will of eating healthy, but also ethically and socially conscious. For this reason, consumers are keener on more natural, animal-free, plant-based, minimally processed, local, and seasonal food. Besides going back to nature, with a growth in demand for organic and naturally healthy products, other categories such as "free-from" and fortified/functional foods are also on the rise.

In line with the clean labelling trend, certain ingredients or categories, such as dairy, sodium, sugar or carbohydrates, are being avoided or limited by an increasing number of consumers. Instead, other ingredients such as proteins or healthy fats, are becoming more popular. With health as the main priority, even beverages, snacks and indulgence foods, are being redefined to incorporate ingredients with demonstrated health benefits.

Other global trends such as personalization, activist consumers against food waste, and IoT, are shaping interaction with food and impacting nutrition. Sports nutrition is rocketing and influencing nutrition trends, possibly being the main responsible for the protein surge. For this reason, and because it is not only a nutrition trend, but also a category itself, it will be reviewed in detail in the section below.

Finally, by way of a summary, Figure 3 shows the global sales of the selected health categories in 2017, reflecting their relevance among the different health categories.

Trends in Sports Foods and Nutrition

Global trends and consumer concerns are shaping changes in nutrition, and thereby influencing the sports nutrition category as well. “Healthy living” stands out as the most relevant global trend impacting the food industry, and it is responsible for the enormous growth that sports nutrition category is experimenting. In line with this increased health awareness, consumers are keener on more natural, animal-free, plant-based, minimally processed, local, and seasonal food, what is also shaping sports nutrition products.

As more consumers become aware of the importance of a well-designed diet for a good training, the use of sports nutrition products is becoming mainstream. Besides being a nutrition trend, it is an important category influencing nutrition trends, possibly being the main responsible for the protein surge. Sports nutrition is a large and quickly growing consumer health category that promotes the achievement of an optimum nutrient intake, which is having positive implications in health care costs and well-being, and for this reason it will be reviewed in detail below.

Sports nutrition, not just a recent trend

Sports foods are those specialized products designed for athletes and active people to improve their nutritional intake, health, wellbeing, performance, muscle growth and/or recovery from exercise. In addition, they can also provide a convenient source of nutrients when it is impractical to consume everyday foods. Whey protein, sports gel or electrolyte replacement drinks are examples of sports foods. Among sports foods, sports nutrition encompasses food/dietary supplements aimed to contribute to an optimal performance (ESSNA, 2018). By law, sports nutrition products can only contain vitamins, minerals, food ingredients, macronutrients, herbal ingredients with a substantial history of use, and other ingredients that are generally regarded as safe (European Parliament, 2002), (United States Congress, 1994). Despite the distinction between sports foods category and sports nutrition subcategory, the two terms are often used interchangeably, also in the following text.

Although sports nutrition is one of the latest trends, it is a much older phenomenon. In the ancient Olympic Games, athletes used to eat massive quantities of meat, bread, dried fruits and honey, along with various fungi and herbs in an attempt to increase their athletic performance. But it was not until the last century when scientists found that certain substances were effective in improving athletic performance, and thereby, the first scientific-based sports nutrition products were created (ESSNA, 2018). A well-designed diet, with nutrient-dense foods, that meets energy intake requirements and incorporates proper timing of nutrients, is the foundation of a good training (Kerksick et al., 2008). However, athletes' dietary needs might be difficult to achieve through food intake alone, and for this reason, dietary supplements and sports nutrition products are often needed. When races are won by mere fractions of a second, and games may be lost due to fatigue, nutrition can make the difference between an athlete and a champion (Spano & Antonio, 2008).

Until recently, only bodybuilders and strength athletes were pushing for nutrient-dense, high-quality, and more convenient sources of nutrition, that could help them satisfy their unique nutritional requirements. However, as a consequence of an increasing scientific evidence on sports nutrition health and performance benefits, more athletes and coaches from other disciplines, embraced the use of these products. In the last

decade, sports nutrition has expanded its consumer base to amateur athletes and active people who not only care about their muscle growth, athletic performance and recovery, but also about their health and wellbeing (Euromonitor, 2015b), (C. S. Euromonitor International's Consumer Health Analyst, 2014).

Sports nutrition market analysis

Consumers worldwide are adopting a healthy living lifestyle and gaining awareness of their needs and proactive steps that can be taken to achieve a higher wellbeing and prevent chronic diseases (Euromonitor International's Head of Lifestyles Research, 2017). Along with this trend, different categories are growing, like the Canadian wearable device market, which includes fitness trackers, and is expected to grow by 150% in 2019. Another example would be that in 2014, more than 41% of Canadians were interested in buying a health monitor (BDC, 2016). So, with health in focus and with the rising mantra "strong is the new skinny", sports nutrition is the fastest growing consumer health category for several years in a row, and it is expected to continue growing at a steady pace in the next years (Mitchell, 2016).

Since more people recognize the benefits of sports nutrition products, the category has seen an enormous growth, from US$6,7bn and US$8,9bn in 2010 and 2013, respectively, to US$10,8bn in 2015. Moreover, forecasts point out that it will continue growing. Sports foods, including not only sports nutrition products, but also sports and energy drinks and bars, were worth US$60bn in 2013 (C. S. Euromonitor International's Consumer Health Analyst, 2014).

Although US is dominating the global market, accounting for over 60% of global sales, the growth is truly global. However, in terms of consumption, developed markets are leading. By way of example, Australia followed by US were leading in consumption in 2013, with an expenditure of US$ 55 and 45 per household respectively; while world average consumption was around US$5 per household. As for low-income markets, despite the barrier of relatively high prices, the global healthy living trend together with the rising disposable incomes, are supporting the increased demand and consumption of sports nutrition products. For this reason, less developed markets such as China, India and Brazil, are evolving and fast growing (C.

S. Euromonitor International's Consumer Health Analyst, 2014), (C. O. Euromonitor International's Consumer Health Analyst, 2017).

Sports nutrition is becoming mainstream

The main reason for the sports nutrition market steady growth is the expansion of its consumer base over the last 10 years (Euromonitor, 2015b). Consumers have an increased health awareness and are increasingly opting for sports nutrition products to complement their work-out sessions (Mordor Intelligence, 2018). As a result, the demand for sports nutrition category and its sales are rocketing.

Sports nutrition products, which are aimed to improve performance, post workout recovery and muscle maintenance and building, were originally designed for elite athletes and body builders in order to keep up with their unique nutritional demands. However, as a result of the healthy living trend, sports nutrition products have become mainstream over the past decade (C. S. Euromonitor International's Consumer Health Analyst, 2014). Besides the constantly increasing fitness clubs, which are exposing more and more recreational sports enthusiasts to sports nutrition products, other key features to support market growth have been innovation, with a growth rate of 10'4% of global product launches between 2011 and 2016, and consumer loyalty. In contrast to what happens to other categories, when users detect a positive difference in performance, they generally stick to it. Thereby, sports nutrition products enjoy a high degree of loyalty (Mordor Intelligence, 2018).

When it comes to consumers, they are not only increasing in number, but also in diversity. As a consequence, knowledgeable and high-volume users who purchase frequently, also known as "core users", no longer dominate sports nutrition sales. In the last decade, sports nutrition products have become more appealing to a greater number of mainstream consumers, often referred to as "casual users", who are recreationally active. They prefer convenient formats and recognizable ingredients (Euromonitor, 2015b). Another group has recently emerged in developed markets, they are the "lifestyle users" who are not particularly athletic but put a greater focus on increasing their fitness levels by trying to do more exercise. Lifestyle users are mainly young and invest in fitness as a fundament aspect of a healthy lifestyle. They are

keen on trying new products, formats and ingredients (C. S. Euromonitor International's Consumer Health Analyst, 2014), (Mordor Intelligence, 2018).

Despite the different characteristics defining each consumer type, what all of them have in common is that they seek transparency, as well as clean and open label formulations (Kang & Hustvedt, 2014). Responding to these demands, third-party banned-substance-free certification has become a standard for major brands and producers. In addition, an increasing number of brands are opening up their proprietary blends with complete ingredient break-outs (C. S. Euromonitor International's Consumer Health Analyst, 2014). In general, a greater focus is put on the presentation of products, including appealing and interactive labelling to make it easier for the consumer to understand the ingredients, and to ensure product safety (Mordor Intelligence, 2018).

Finally, as a consequence of the consumer base expansion and segmentation, sports nutrition products are consumed for different purposes. For this reason, companies are discussing whether a better name for the industry would be lifestyle nutrition or active nutrition, which would appeal to more consumers, helping to continue broadening the consumer base (C. O. Euromonitor International's Consumer Health Analyst, 2017). In line with this last objective, major brands are penetrating mainstream distribution channels, such as gyms, pharmacies and supermarkets. For this reason, products that were once only available in dedicated fitness shops, have made their way to other retailers. In addition, sports nutrition products are also distributed by online sellers, accounting for 41,3% of sales in the US in 2017 (Mordor Intelligence, 2018).

Proteins will not abdicate – and continue leading

Proteins dominate global sales, in no small part as a consequence of being the most accessible and understandable sports nutrition ingredient. While non-protein products were worth US$1,6bn in 2013, this is 17% of the total sports nutrition market; protein products, including powder, bars, ready-to-drink beverages and others, have been growing at a steady pace, reaching US$7,3bn in 2013 and US$9,2bn in 2015, accounting for more than 83% of the total sports nutrition market. In addition, 6,5% compound annual

591 growth is forecasted for protein products during the time frame between 2015 and 2020. In fact, protein
592 market is expected to reach US$13,5bn in 2020 (C. S. Euromonitor International's Consumer Health
593 Analyst, 2014), (Euromonitor, 2015b).
594
595 Protein claims related to muscle mass growth, lean muscle maintenance and recovery from resistance
596 exercise, makes protein the most demanded product on sports nutrition category. Protein is especially
597 appealing for younger consumers, aged 15-34. Its popularity benefits from media praise and still has room
598 to grow, particularly in emergent markets such as China, Latin America and India. Other lesser known
599 protein benefits are satiety, bone and heart health, and antiaging, which are perfectly aligned with global
600 concerns about overweight, obesity, cardiovascular health and aging. Provided that these claims become
601 mainstream, proteins will potentially appeal to millions more in the near future (Euromonitor, 2016). As a
602 result of its reputation as a health-promoting ingredient, natural-containing protein products and protein
603 fortified foods, are also gaining popularity among mainstream consumers.
604
605 In the sports nutrition category, protein products remain the most demanded, as they offer a convenient
606 way of meeting increased protein requirements without excess calories, fats or sugars. When it comes to
607 the format, protein powder accounted for 70-80% of total protein products and reached US$5,6bn in 2013.
608 However, convenience formats, like ready-to-drink beverages, or protein bars, are growing quickly and
609 reached US$ 766mn and 837mn, respectively, in 2013 (Euromonitor, 2016).
610
611 - *Whey protein – a sales king that is being challenged*
612 Among protein powder products, which usually need to be mixed with water or milk, whey is the king of
613 sales. Casein, egg and soy proteins are also fairly common (Euromonitor, 2015b), (Euromonitor, 2016).
614 However, in nutritional terms, whey is one of the best quality protein sources, and it delivers a greater taste
615 than the offered by other sources. Besides its content in essential amino acids and BCAA, whey proteins
616 are also well-known for its easy digestion and quick absorption, which ensure a fast delivery of the building
617 blocks required for lean muscle mass growth and recovery (Hoffman & Falvo, 2004), (Patel, 2015). In fact,

published scientific research has demonstrated that in relation to other protein sources, whey protein promotes greater muscle-building activity and muscle mass gains (Hoffman & Falvo, 2004).

For a long time, whey protein isolate was only popular among core users, but due to a trickle-down effect, its consumer appeal is widening (C. S. Euromonitor International's Consumer Health Analyst, 2014). In addition, whey protein is versatile and easy to use in product applications, so it is also popular among manufacturers (Agarwal, Beausire, Patel, & Patel, 2015). However, as casual and less-sophisticated users increasingly opt for whey protein products, core users are shifting to sustained-release protein blends, which could also gain mass acceptance in the near future (C. S. Euromonitor International's Consumer Health Analyst, 2014). These new formulations, including mixtures of different protein sources and protein treatments (concentrate, isolate and hydrolysate), are challenging whey protein isolate as king of protein sales (Euromonitor, 2016). Other factors, such as sustainability and animal welfare, are increasing the demand for plant-based proteins and therefore, increasing the challenge for whey protein (Radnitz et al., 2015), (Hancox, 2018).

Last but not least, in line with the healthy nutrition trend, high-protein and added-protein foods, which are already in full-swing, could pose a long-term threat to specialized sports protein products; especially among casual and lifestyle users (Chittock, 2013). In addition, although scientific evidence confirms protein supplementation safety, some dietitians are questioning the need and safety of protein supplementation, posing another threat to sports protein products (Antonio et al., 2016).

- *Rising demand for plant-based proteins*

With over 80% of sports nutrition sales coming from protein-based products, and a global high-protein diet trend, sports protein products will continue to lead the industry (C. O. Euromonitor International's Consumer Health Analyst, 2017). However, consumers are increasingly asking for free-from, non-allergenic and plant-based products; and proteins are not the exception. With 3% of US population eating a strictly vegetarian diet, and 36% opting for at least vegetarian meals on a regular basis in 2016, there is a growing demand for plant-based proteins (Vegetarian Resource Group, 2016). Sustainability, animal welfare and a decrease

in reliance on animal-based nutrition are driving the demand for alternatives to milk proteins (C. S. Euromonitor International's Consumer Health Analyst, 2014), (Radnitz et al., 2015), (Hancox, 2018).

Plant-based proteins from soy, pea or rice are less common than whey protein, but they are growing quickly and will continue to do so (Euromonitor, 2016). In fact, scientific evidence shows that plant-based proteins can be as effective as animal proteins for muscle maintenance, as long as the selected source, delivers all the essential amino acids needed (Mangano et al., 2017). In addition, a well-designed vegetarian or vegan diet provides sufficient energy and appropriate range of carbohydrate, fat and protein intakes to support performance and health (Venderley & Campbell, 2006), (Lynch et al., 2016). For this reason, certain elite athletes are going vegan and beginning to consume plant-based proteins, thereby contributing to plant-based proteins consumer base expansion (Edsor, 2017).

- *Hydrolysates are the next big thing – life is too short for slow proteins*

Differences in protein source, amino acid profile, and processing methods, can have an influence on amino acids bioavailability. Hydrolysates are high-quality proteins that have been finely chopped or predigested so that they can be absorbed faster than conventional proteins, helping to cut muscle recovery times from days to hours (Manninen, 2009). For this reason, they play a greater role in those athletes who place higher pressure on their body due to exercise frequency and intensity, and those who have a small window for recovery. Although hydrolysates future is promising, its bitterness and astringency hinders its incorporation into beverages, bars and gels (FitzGerald & O'Cuinn, 2006), (Liu, Jiang, & Peterson, 2014). This is not a drawback for core users, but since casual users prefer convenience products with good taste, until now hydrolysates have had a slow expansion. However, recent advances in hydrolysates processing technology have allowed taste-masking, enabling its incorporation into various formats such as clear drinks (FitzGerald & O'Cuinn, 2006). As a consequence, a fast growth for hydrolysates is forecasted (Euromonitor, 2015b).

<u>What about non-protein products?</u>

Casual users' adoption of non-protein products is growing. However, since these products are more difficult to understand by the mainstream and uninformed consumers, they mostly appeal to core users. With sales

reaching US$160mn in 2013, UK has a leading position in the global non-protein products market. Global sales were worth 1,6bn in 2013 and are expected to grow by nearly US$500mn, achieving US$2bn in 2018 (C. S. Euromonitor International's Consumer Health Analyst, 2014).

In general, fitness-focused lifestyle, a desire for fast results, and a high demand for portable and convenient products, are the main drivers of the sports nutrition category. When it comes to convenience formats, non-protein products have been ahead, leading the experimentation. Gels, chews, bars, sachets and shots are examples of convenience formats. With the rise of endurance sports, gels have become the most popular convenience format (Euromonitor, 2015b), (C. S. Euromonitor International's Consumer Health Analyst, 2014).

As for sports drinks, they are expected to record the highest growth rate in the following years. Sports drinks, including products sold in powder to be rehydrated in water, are highly demanded as consumers become aware of the uses and benefits of drinks rich in carbohydrates, minerals and electrolytes (Zimberoff, 2017). Active and sports people have higher carbohydrate requirements, and without an adequate intake of them, exercise performance decreases (Williams & Rollo, 2015). Electrolyte-replacement, glucose-containing solutions help to maintain blood glucose levels and prevent dehydration and therefore, may delay fatigue and attenuate muscle damage during endurance exercise (American Dietetic Association et al., 2009). However, the growing sugar-averse consumer base is contributing to an increased demand for low-calorie and low-carbohydrate sports drinks, especially in North America, which is the leader in sales (International Food Information Council Foundation, 2018). New sports drinks are mainly focused on optimizing hydration before, during and after physical activity. Maintaining hydration status is one of the most effective ways to maintain exercise performance, which can be significantly impaired when 2% or more of body weight, is lost through sweating (American Dietetic Association et al., 2009),(Ronald J. Maughan & Shirreffs, 2012).

In 2013, sports drinks and energy drinks accounted for US$18,7bn and US$27,6bn, respectively. However, there is a blurring line between energy/sports drinks, and non-protein products category (C. S. Euromonitor

International's Consumer Health Analyst, 2014). The main reason for this, is that energy/sports drinks are shifting from the so-called bad carbs to the good ones. This is translating into products with lesser amounts of ingredients with minimal other nutritional value, like sugar or starches; and with higher amounts of naturally-containing-carbohydrates fruits, vegetables and whole grains (International Food Information Council Foundation, 2018). Strongly aligned with plant-based trend, this new wave of products is blurring the line between energy/sports drinks, and other drinks or beverages in the non-protein products category.

An overview of sports nutrition products' global sales

Before moving forward with other trends to look out for in 2020, Figure 4 shows the global sales of the selected sports foods subcategories in 2013, thus reflecting their relative relevance.

Other trends to look out for in 2020

Nutrient timing is a well-known concept for elite athletes, and casual users' awareness of its importance is increasing. Meal times and snacks should be planned in concert with training, to make sure that athletes have sufficient availability of nutrient-dense foods throughout the day. Research has shown that meal timing and composition may play a role in optimizing performance, training adaptations and preventing overtraining (Kerksick et al., 2008). By way of example, within 30 minutes of a workout, consuming high-quality carbohydrate and protein is key to replenish those nutrients depleted during the workout. While carbohydrates replenish glycogen stores and therefore, support muscle recovery, protein helps in muscle building and repairing (American Dietetic Association et al., 2009).

Global trends such as transparency, clean labeling and personalization are also impacting sports nutrition. Besides those that have already been discussed before, customized workouts and meals, tailored to preferences and goals, will help optimizing physical activity. "One size fits all" will no longer exist, and appeal for personalized fitness plans and nutrition, will broaden from elite athletes to include casual users as well (German, Zivkovic, Dallas, & Smilowitz, 2011), (Nutraingredients, 2016), (Gardiner, 2016).

Recovery is gaining importance over rest. While resting is just the absence of training, recovery involves all techniques and activities to maximize repair: hydration, compression, nutrition, heat or cold, stretching and massaging (Menzies et al., 2010). For a long time, a lot of these techniques were only reserved for elite athletes, but casual users' adoption is increasing as they are becoming aware that a balance between rest and recovery, together with a proper nutrition is essential for anyone who exercises (Meltzer, 2018), (Mateo, 2018).

Finally, flavor is one of the most important areas for innovation in the sports nutrition industry, and it has a long way to go in terms of customers acquisition and retention (Cash, 2017). Another main driver of sports nutrition industry is convenience packaging, since consumers prefer small and portable products (Euromonitor, 2015b), (Euromonitor International's Head of Lifestyles Research, 2017).

Innovation is driving the market – microencapsulation as an example

Besides demand-driven innovation, offering technological and professional solutions to mass market consumers is a powerful driver for growth and competitive positioning of a company (PwC, 2013). In this line, technologies such as microencapsulation would allow a broader use of certain ingredients with organoleptic or stability issues, among others. Microencapsulation is a technique that involves the entrapment of a substance within a microscopic shell of encapsulating polymeric material to give microcapsules different useful properties: preventing interactions among ingredients of a formula, flavor masking, increased stability and bioavailability, improved dissolution and flowability, and sustained-release among others (Gaonkar, Vasisht, Khare, & Sobel, 2014).

By way of example, taste-masking microcapsules allow the incorporation of caffeine into gels or chews without its characteristic bitter taste (Pimparade et al., 2015), (Mohammadi, Ehsani, & Bakhoda, 2018). Other examples of microencapsulation applications are increased water-dispersibility and bioavailability of hydrophobic ingredients, such as coenzyme Q10 or medium chain triglycerides (Gaonkar et al., 2014). Microcapsules are also capable to increase the stability of certain sensitive ingredients, such as probiotics, when they are exposed to different environmental conditions like heat, humidity, light and oxygen (Anal &

Singh, 2007). Furthermore, microcapsules can act as delivery systems. Depending on the microencapsulation technique and wall material selected, the release mechanism can be triggered by different factors such as dissolution, temperature, pressure, pH and enzymes among others; and the release profile can also be modified to be immediate, delayed or sustained (Gaonkar et al., 2014). Finally, microcapsules are also capable to protect acid-sensitive ingredients, like probiotics or enzymes, during their pass through the highly acidic environment of the stomach, and to release them in the intestine, which has an alkaline pH (Anal & Singh, 2007), (Cook, Tzortzis, Charalampopoulos, & Khutoryanskiy, 2012).

Finally, as has just been reviewed, the implementation of professional solutions for mass market products, can help overcome different challenges, from technical issues like shelf-life, to consumer acceptance problems, like unpleasant taste or poor dissolution. Until now, technological advances were a business-to-business tool due to a lack of consumer understanding. However, consumers access to information is greater than ever, and soon they will become aware of the benefits of these techniques (Hamari et al., 2016). For this reason, technological solutions are going to be crucial to differentiate products from their competitors (PwC, 2013).

Considerations on regulation

Last but not least, the sports nutrition category is not only shaped by dietary recommendations and research, but also by regulations. Each country has its own regulation, which has an impact on the direction and growth of the sports nutrition industry. While some countries can select from a wide range of ingredients and claims, other countries may restrict or ban the same ones (R. J. Maughan, Greenhaff, & Hespel, 2011).

The US and the European Union (EU), by their respective competent bodies, Food and Drug Administration (FDA) and European Food Safety Authority (EFSA), have its own composition and labelling requirements, which will be briefly reviewed below. It is important to remark that besides the benefits provided by supplements and sports food, safety remains the main priority (US Congress, 2011). When it comes to professional athletes competing under anti-doping codes, not only evidence and safety are important factors to consider, but also the absence of prohibited substances. For this reason, it is important to highlight

a valuable information resource developed by the Australian Institute of Sport. It consists of an ABCD classification system that ranks those ingredients found in sports foods and supplements, into four groups. It is based on scientific evidence and other practical considerations to stablish product safety, legality and efficacy in improving sports performance (Australian Institute of Sport, 2018).

- *US regulation*

In US, according to the Dietary Supplement Health and Education Act, dietary supplements are defined as products taken by mouth, which are typically sold in the form of capsules, soft gels, liquids, powders and bars, and that contain one or more dietary ingredients intended to supplement the diet. Vitamins, minerals, herbs, botanical extracts, amino acids and other substances may be considered dietary ingredients. Products sold as dietary supplements must be clearly labeled as such. FDA monitors its manufacturing processes, quality and labelling, but it grants a greater control over supplements containing new dietary ingredients. A new dietary ingredient is a dietary ingredient that was not sold in the US before 1994. FDA requires specific safety information from manufacturers intending to market food supplements containing new dietary ingredients. Safety evidence, which may include in vitro and long-term toxicity studies, and clinical studies in humans, must be provided to FDA. When it comes to health and nutrient content claims, efficacy evidence must be submitted to FDA for approval. Authorities can act against companies who make false or misleading claims; and can also remove supplements from the market if they lack sufficient scientific evidence to demonstrate product safety. In addition, companies are now required to record all adverse event complaints about their products; and must report to FDA all those serious adverse events (United States Congress, 1994), (US Food and Drug Administration, 2018).

- *EU regulation*

As for the regulation in Europe, according to European Parliament Directive (2002/46/EC), food supplements are defined as products intended to supplement the normal diet, consisting of concentrated sources of nutrients, like minerals and vitamins, or other substances with a nutritional or physiological effect that are marketed in a “dosage” form (e.g. pills, tablets, capsules or liquids in measured doses). Food supplements are regulated as foods, and thereby may contain vitamins, minerals, amino acids, essential

fatty acids, fiber and various plants and herbal extracts, among others. It has to be noted that the addition of nutrients or other substances to fortify foods, does not fall within the definition of a food supplement, and is addressed by a different regulation. Food supplements are intended to correct nutritional deficiencies, maintain an adequate intake of certain nutrients, or support specific physiological functions. The responsibility for the safety of these products lies with the food business operator placing the product on the market (European Parliament, 2002).

In order to protect consumers against potential health risks, EFSA carried out a comprehensive assessment of substances that could be intended for food supplements manufacture in the EU. Based on EFSA's work, the European Commission established a harmonized list of substances that may be used in the manufacture of food supplements, their tolerable upper intake levels, labelling requirements and approved health claims (European Parliament, 2006b), (European Food Safety Authority, 2006), (European Parliament, 2011), (European Parliament, 2006a). There is also a list of those substances that are known or suspected to have adverse effects on health, and the use of which is therefore controlled. As for those substances intended to be used in food supplements, and that do not have a history of safe use in the EU before 1997, which are known as "novel foods", EFSA is requested to provide a scientific opinion on its safety (European Parliament, 2015).

Finally, the EU register provides information on the permitted nutrition and health claims made on foods, and their conditions of use and applicable restrictions, as well as non-authorized health claims and the reason for their non-authorization (European Commission, 2018).

- *Worldwide anti-doping regulation*

The World Anti-Doping Agency (WADA) is an international independent agency with scientific research, education, development of anti-doping capacities, and monitoring of the world anti-doping code, as key activities. Its mission is to lead a collaborative worldwide movement for doping-free sport, bringing consistency to anti-doping policies and regulations within sport organizations and governments across the world (World Anti-Doping Agency [WADA], 2018a). The list of prohibited substances and methods, which

is updated annually, is a cornerstone of the WADA. It lists substances prohibited at all times, just in-competition or in particular sports. Some examples of prohibited substances are non-approved pharmacological substances, anabolic agents, beta-2 agonists and diuretics, as well as masking agents. Examples of prohibited methods are manipulation of blood, chemical manipulation of samples collected during doping control and gene doping (WADA, 2018b).

According to world anti-doping code, athletes are responsible for all products ingested and any subsequent legal, health or safety consequence (WADA, 2015). For this reason, they should pay special attention when choosing a supplement, since some of them have been reported to have an accidental or deliberate content of banned substances (R. Maughan, 2005). A research of stimulants and anabolic steroids in dietary supplements revealed that the number of mislabeled supplements represented 18% of the 103 products analyzed (Baume, Mahler, Kamber, Mangin, & Saugy, 2006). For this reason, some manufacturers order commercial third-party auditing programs, as an independent screening for banned and restricted substances that could be accidentally found in their dietary supplements. These certifications provide a greater assurance of supplement purity for those athletes competing under antidoping codes (Bishop, 2010). Non-intentional doping poses a threat to athlete's career, since anti-doping rule violation, regardless it was intentional or unintentional, may result in bans of up to four years (WADA, 2015).

Sports nutrition trends in brief

In line with the healthy living global trend, as consumers are increasingly focusing on health and fitness goals, different categories, like wearable devices, are growing. Sports nutrition is the fastest growing consumer health category for several years in a row, and it is expected to continue growing at a steady pace in the following years. An expanding and more diverse consumer base is boosting the demand for sports nutrition, which has become a mainstream category. For this reason, products that were once only available in dedicated fitness shops, have made their way to other retailers.

As for the sports nutrition king ingredient, proteins dominate global sales accounting for more than 83% of total sports nutrition market. Since proteins are the most accessible and understandable sports nutrition

category, further growth is forecasted for the next five years. Among protein powders, whey isolate is the preferred source, due to its taste, amino acid composition and quick absorption. However, new formulations including different sources and treatments of proteins, are challenging whey protein isolate as king of sales. The main threats for whey protein isolate are a rising demand for plant-based proteins, and hydrolysates of different protein sources.

On contrast, non-protein products are more difficult to understand by the mainstream and uninformed consumers, and account for just 17% of total sports nutrition market. Despite not leading in sales, non-protein products are way ahead of convenience formats experimentation. As for sports drinks, they are expected to record the highest growth rate in the following years. Electrolyte-replacement, glucose-containing solutions help to maintain blood glucose levels and prevent dehydration, and therefore, may delay fatigue and attenuate muscle damage during endurance exercise. However, since there is an increasing demand for low-calorie and low-carbohydrate sports drinks, new products are mainly focused on optimizing hydration.

Besides global trends like clean labeling and personalization, which are impacting sports nutrition, other emerging trends to look out for in 2020 are nutrient timing, recovery gaining importance over rest, convenience packaging, and flavor as one of the main areas for innovation. Finally, offering professional solutions to mass market is key for disruptive innovation. Application of technologies such as microencapsulation in the sports nutrition field, would allow a broader use of certain ingredients with organoleptic or stability issues. In addition, preventing interactions, improving dissolution and achieving a sustained-release profile by means of microencapsulation, could also drive the sports nutrition category.

Last but not least, when it comes to the direction and growth of the sports nutrition industry, it is shaped by different factors. One of the most relevant but frequently forgotten factors is regulation, which can be different in each country. Competent authorities can restrict or ban ingredients to ensure safety and can also regulate to avoid false or misleading claims. Professional athletes who compete under anti-doping

codes, may only consider certain manufacturers which provide a third-party certificate ensuring that no banned or restricted substance is present.

Conclusion

Global dynamics are shaping consumer attitudes and thereby, promoting changes across industries. Clean and healthy living stands out as the most relevant trend impacting the food industry. Consumers are making informed decisions to prioritize healthy, plant-based, sustainable and socially-conscious food purchases, a trend which is also affecting beverages, snacks, indulgence foods and even fast food. Aligned with this trend, governments are promoting healthy habits to reduce morbidity and cut off its associated costs. In this context, not only vegetarian and vegan product sales are growing quickly, but also organic and free-from products. In addition, since consumers prefer foods with an intrinsic nutritional value, functional foods have been outpaced by naturally healthy products.

Due to media praise and sports nutrition, a category where protein is the king of sales, consumers are increasingly looking for high-protein products. Carbohydrates, instead, have been targeted as a strategy to reduce overall calorie intake, resulting in a decreased popularity. However, the source matters, and “good carbs” are used instead of “bad carbs”. In this line, as consumers increasingly avoid certain food ingredients, clean label products are no longer a trend, but the new norm. Nonetheless, the replacement of certain ingredients may set up costly and sometimes unnecessary challenges for food scientists. Other relevant trends shaping interaction with foods are personalization, IoT, and food waste reduction. However, one of the main trends is sports nutrition, which is a large and quickly growing consumer health category.

Sports nutrition sales are no longer dominated by core users, instead, they have become more appealing to mainstream consumers, and as a result, sports foods have made their way to mainstream distribution channels. Proteins are leading the sports nutrition category, but whey protein isolate, which is the king of sales among protein powder products, is being challenged by the rise of high-protein foods and the rising demand for plant-based proteins. When it comes to protein processing methods, isolates are being replaced by hydrolysates, which are expected to be the next big trend among protein powders. As for non-protein

924 products, despite experiencing a slower growth, they are leading the experimentation in convenience
925 formats. Regarding new sports drinks products, they are mainly focused on optimizing hydration, and
926 shifting from the so-called bad carbs to the good ones. As a consequence, there is a blurring line between
927 energy/sports drinks, and other non-protein drinks or beverages.
928
929 Other trends to look out for in 2020 in the sports food industry are nutrient timing, personalization, recovery
930 gaining importance over rest, and flavor as one of the most important areas for innovation. Different
931 professional technologies can be applied to mass market products, as a driver for growth and competitive
932 positioning. In this context, microencapsulation stands out as one of these technologies with a wide variety
933 of applications and a promising future. Finally, besides innovation, dietary recommendations and research,
934 the sports nutrition category is shaped by regulations; among which stand US and EU regulation, and World
935 Anti-Doping Code.
936
937 To conclude, global dynamics have an influence on nutrition trends, being potentially disruptive for the
938 correct balancing of the diet. However, as it has been reviewed, along with the healthy living trend, more
939 people are adopting an active lifestyle, embracing a healthier dietary pattern and recognizing the benefits
940 of sports foods, which is having positive implications in health, well-being and healthcare-associated costs.
941 This review has also provided an overview of the areas that are more prone to development, and that
942 should be added to the research agenda to adapt formulas and technologies to consumer needs.
943

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949 Conception, literature research and writing were performed by M. Arenas-Jal. Field experience, planning
950 and critical review of the manuscript were performed by J.M. Suñé-Negre, P. Pérez-Lozano, and E. García-
951 Montoya.

952

953 **Abbreviations**

954 AGAUR: Agency for Management of University and Research Grants

955 bn: billion

956 EFSA: European Food Safety Authority

957 EU: European Union

958 FDA: Food and Drug Administration

959 GMO: Genetically Modified Organism

960 IoT: Internet of Things

961 mn: million

962 UK: United Kingdom

963 US: United States of America

964 WADA: World Anti-Doping Agency

965 WHO: World Health Organization

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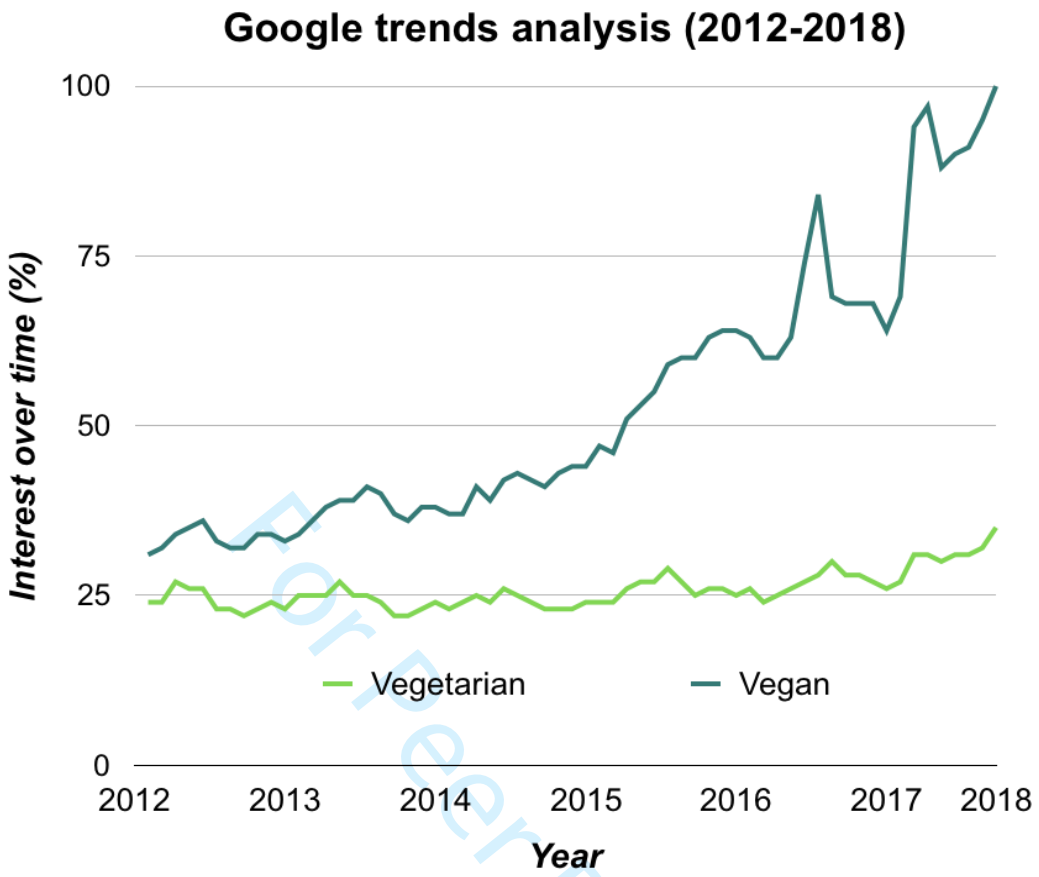
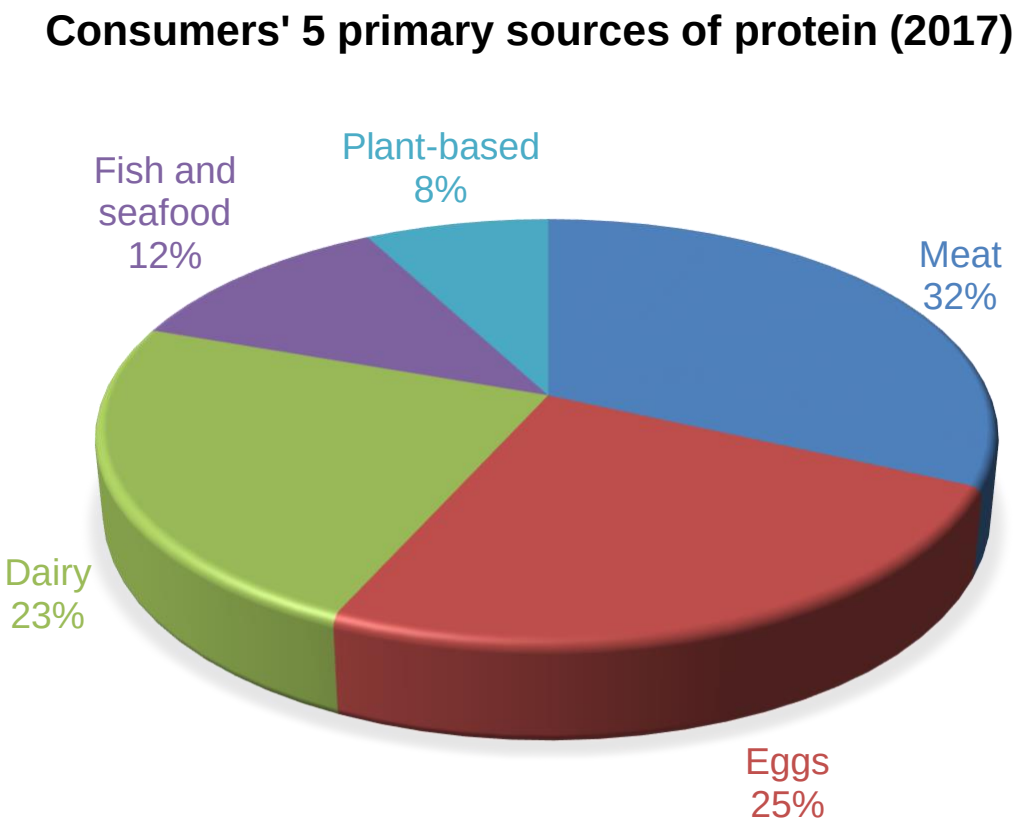


Figure 1. Interest over time of "vegetarian" and "vegan" search terms (Google Trends, 2018).



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1263 *Figure 2. Top five protein sources via consumer survey (The Nielsen Company, 2017).*

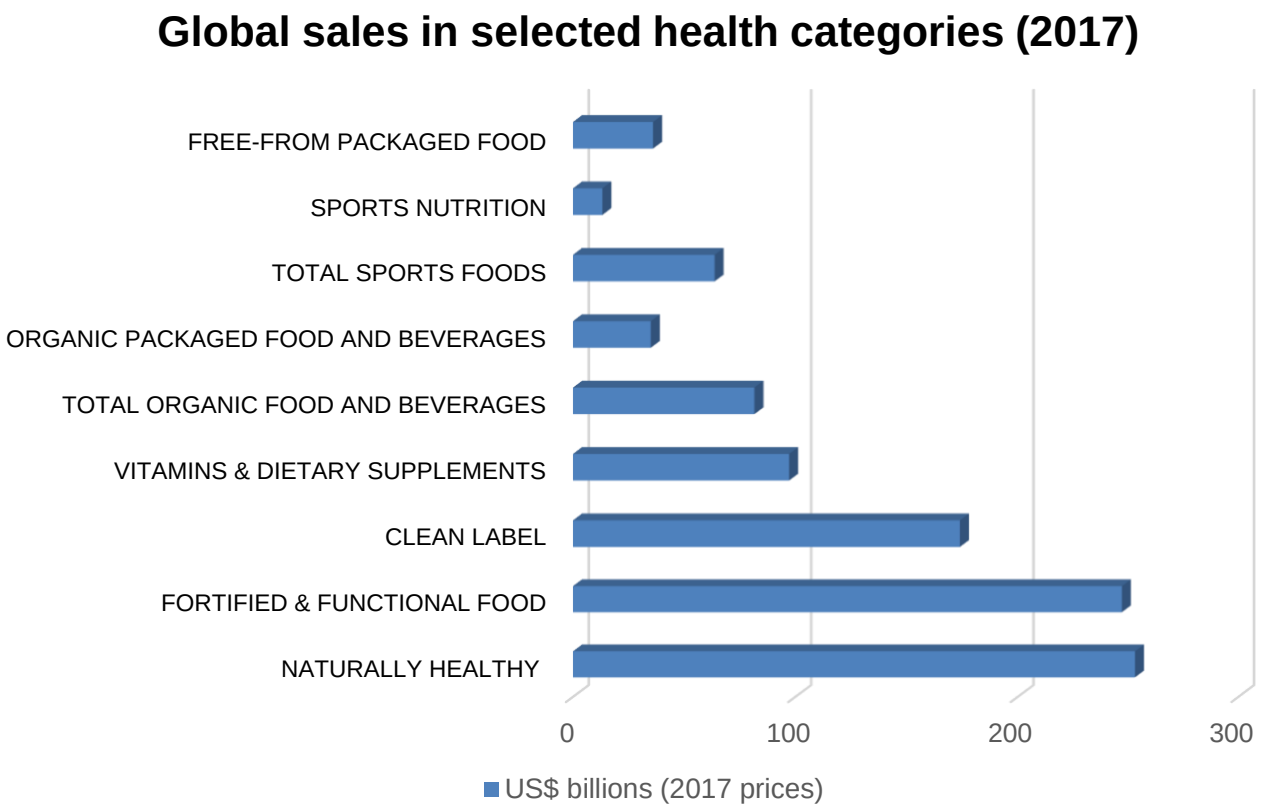

Figure 3.Global sales in selected health categories – 2017 (Euromonitor International's Head of Lifestyles Research, 2017), (Sahota, 2012), (FIBL and IFOAM, 2017), (Euromonitor, 2015a), (Daniells, 2018), (M. M. Euromonitor International's Consumer Health Analyst, 2018), (Bizozzero, 2017), (C. S. Euromonitor International's Consumer Health Analyst, 2014).

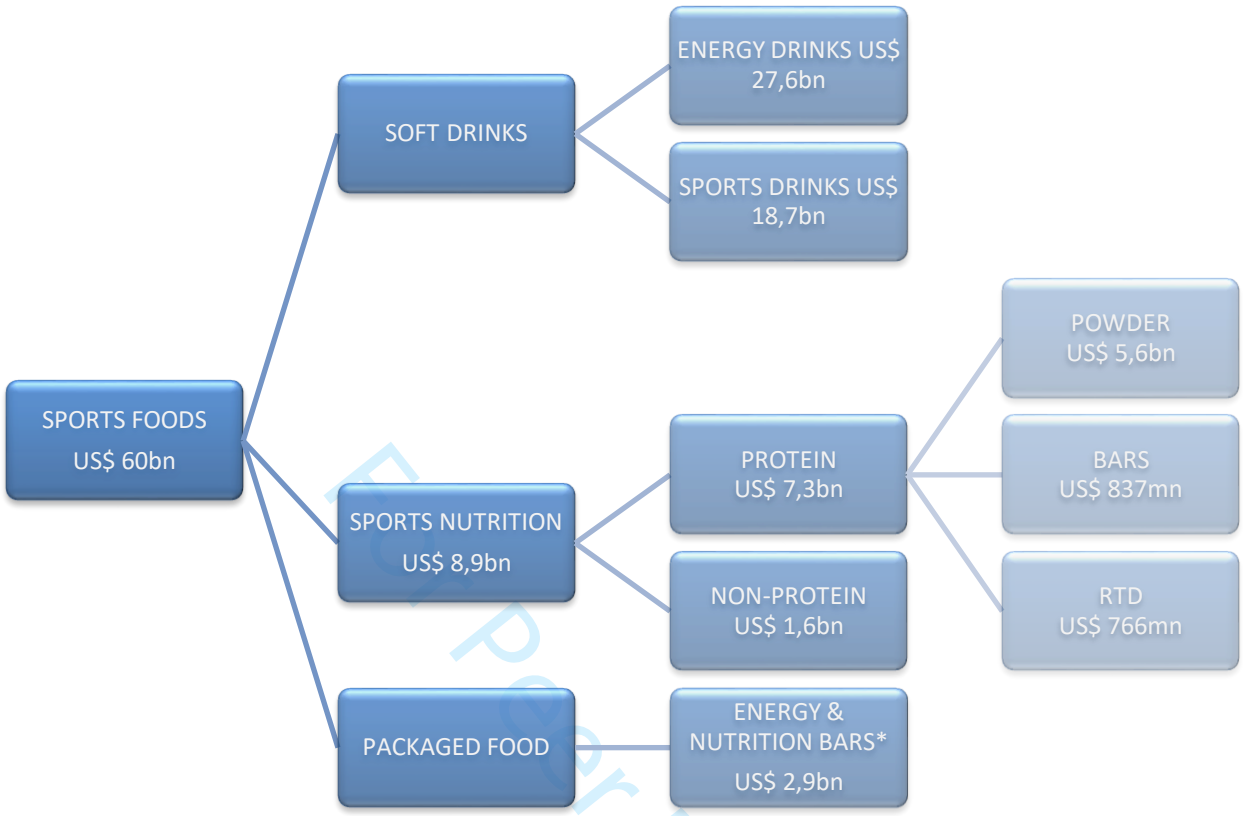

*Figure 4.Global sports foods sales by categories (global retail value, US$ bn, constant 2013 prices). (C. S. Euromonitor International's Consumer Health Analyst, 2014), (Euromonitor, 2015b), (Euromonitor, 2016). * Excluding sports nutrition protein bars.*