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SPECIAL ARTICLE

The future of diet: what will we be eating in The future?☆

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Abstract Food habits and preferences of our population are continuously changing throughout the world, especially in the wealthier countries. One of the consequences in our environment is the abandonment of the Mediterranean Diet, in accordance with an increased consumption of processed and ultraprocessed food, with negative effects on our health by the progressive increase of obesity and its multiple metabolic consequences. On the other hand, foods production is one of the most important reasons for the global warming of the planet, triggered by an increased demand of foods, caused by the grow up of the world population and by the introduction of technologies no respectful with the planet. Fortunately, every day the population is more and more awareness of the need for changing the alimentary model and the news technologies, looking for minimizing such deleterious consequence, always thinking in the health of the people and the planet. This concept, looking for a global welfare for the present and for the future, is discussed in this manuscript.

PALABRAS CLAVE
Dieta planetaria;
Alimentos disruptivos;
Proteínas alternativas;
Sostenibilidad ambiental

El futuro de la dieta: ¿cómo nos alimentaremos en el futuro?

Resumen Actualmente está cambiando el estilo de alimentación en el mundo, especialmente en países con mayores recursos. Eso se traduce, en nuestro entorno, en el abandono de la dieta mediterránea y el aumento del consumo de alimentos procesados y ultraprocesados, lo que supone un efecto negativo sobre la salud, de lo que es un ejemplo la pandemia de obesidad y sus complicaciones metabólicas. Junto a ello se sabe que la alimentación, en el proceso desde su producción a su consumo, es una importante causa del calentamiento global. En contraste,

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cada vez crece mas la sensibilidad poblacional para que la futura innovación alimentaria tenga en cuenta que los nuevos alimentos respeten al ser humano y al planeta, en lo que sería una salud y bienestar global. Aquí reflexionamos sobre esta encrucijada y cómo se podrá definir un nuevo modelo alimentario, respetuoso con el planeta y saludable para la población presente y futura.

During the history of humanity, the diet of populations has depended on what was produced in each region. Furthermore, given the problems of transport and the perishable nature of the majority of products, there was little exchange between populations. Climatic similarity and the peculiarities of the terrain over wide geographical areas meant that the people who lived there had similar dietary and culinary customs, as was the case with the Mediterranean diet. Nevertheless, over recent decades and thanks to food preservation technology, intensive production and improved transport, eating habits have become more uniform around the world, with a gradual loss of local peculiarities. The Mediterranean diet is one such example, as it is now progressively falling into disuse. This is clear in the media, with headlines such as ''Spain is moving further away from the Mediterranean diet'', or ''Betrayal of the Mediterranean diet: not even half the Spanish population eats it''.[1,2] All of this is in spite of overwhelming scientific evidence which confirms that this is one of the healthiest diets. It is able to reduce the risk of suffering the vast majority of the diseases which cause death in the modern world. Such diseases now form a continuously growing pandemic, which includes entities like arterial hypertension, dyslipidaemia, obesity, diabetes, metabolic syndrome, the cardiovascular diseases, several types of cancer, neurological processes (cognitive deterioration, mood disorders and, to a lesser degree Parkinson's disease), non-alcoholic fatty liver and total mortality.[3] Although they are abandoning our traditional diet, consumers increasingly base their diet on health concerns. It would therefore be of interest to take their opinions into account, as if they are well-informed this may motivate them to seek healthier foods, leading consumers to agree with nutritionists. In connection with this, and to create a bridge between consumers and producers, the European Union has created the European Institute of Innovation and Technology (EIT Food). Its objectives include the development of an inclusive and innovative community composed of managers in all of the different food sectors. It actively involves consumers with industries and food innovation entrepreneurs.[4] To draw up guidelines for the future, in 2021 this institute prepared a document showing the five preferences selected by consumers about how the food and agriculture industry should develop.[5] These preferences are shown in Table 1, and they are described below.

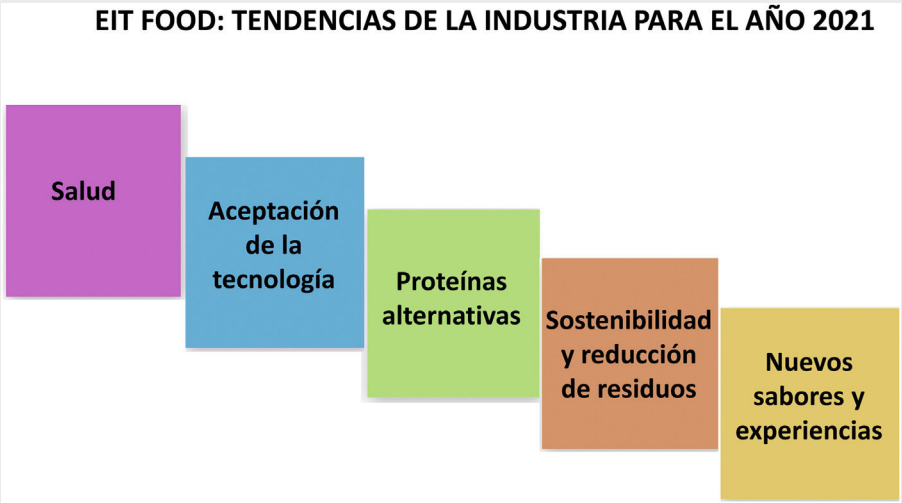
Health is the priority for consumers

Consumer awareness of the importance of diet and lifestyle for health increased in 2021. Because of the COVID-19 pandemic, this idea grew due to increasing interest in how diet and lifestyle could affect the severity of the disease. Many companies now even offer consumers services based on personalized nutrition, offering them supplements based on the information they themselves supply. This information includes data on their lifestyle and analytical results, ensuring that the results of these initiatives are both transparent and traceable.[5] Such initiatives are unfortunately not free of limitations, largely because they lack sufficient scientific backing because innovation precedes evidence. An example of this occurred in recent years with products for obesity which aimed to remedy this process, as they were found to be unable to control the pandemic of obesity. Nevertheless, this concern about health and diet has been positive, as it has led many governments to seek effective labelling for foods that empower consumers to take decisions about what to purchase and consume. Nutri-Score labelling is an example of this, and the aim was to apply it in Spain in 2021. However, there was no evidence that it would be both suitable and independent of the interests of major food corporations.[6] A paradoxical phenomenon is arising within this context of informed consumer interest in health: the commercial strategy of the industry seeks to increase the consumption of highly processed foods, replacing traditional meals. These products are popular because of their low price, but they also constitute a risk for human health, as we shall see.[7] Thus although industry will continue to use health as bait to sell products which do not always fulfil this promise, consumer interest and demand can be expected to drive creative innovation that will give rise to products which really are beneficial.

Increasing interest in convenience and technology

Convenience and technology are two other aspects which are expected to influence future innovation and even our behaviour. This has already occurred to a certain extent thanks to the COVID-19 pandemic, when consumer food purchasing behaviour changed. The habits involved in planning

Table 1 Consumer preferences to guide the development of the agricultural and food industry in 2021.



Source: EIT Food.[5]

and carrying this activity can be said to have changed irreversibly. Online technologies are increasingly used, enabling providers to develop more direct services, and it is believed that their popularity will continue to grow. Additionally, parallel to this renewed interest in home cooking has arisen, above all among young Europeans who are cooking for the first time in their lives. There has also been massive rapid development of new food production technologies, to offer us products that were previously unknown. This has been aided by increased interest in artificially-made products, using techniques such as vertical farms. Products from these farms may start to be commercialized next year: they have major advantages in terms of sustainability, with lower water consumption and less land use.[5] The Green Onyx is another good example of such innovation. This Israeli company sells equipment to produce a tiny aquatic plant in the home. This Asian plant is called ''green caviar'', and it is able to duplicate its biomass every 48 h. This means we can have a garden in our kitchen and use it to grow very healthy food which is an important source of iron, calcium, magnesium, antioxidants, omega 3, omega 6 and vitamins. It contains 30% fibre and is 40% protein, making it an important alternative source of protein.[8]

Interest in alternative proteins will continue to increase

The search for alternative proteins will intensify, and this will make it possible to resolve the problem of the high demand for foods with an animal origin. The different options would include synthetic proteins, those from insects or from cellular agriculture. One of the ideas which best illustrates this interest is the successful search for alternatives to traditional hamburgers. This arose because of their harmful effects on health, their negative impact on animal well-being and the damaging environment effect of their production. It should not be forgotten that of the three main greenhouse gases, carbon dioxide, methane and nitrous oxide, cattle farming contributes 9%, 39% and 65% of the total, respectively. Furthermore, consumption is expected to double in the next 40 years, even though production is now at almost maximum capacity, at least in developed countries.[9] A range of alternative hamburgers have been developed with differing degrees of success. One approach is to make products with a similar composition to meat but with a vegetable origin, such as Beyond meat or Impossible Foods, both of which are now sold in supermarkets and restaurants, especially in the United States. Another approach is to produce meat in the laboratory, as has successfully be done in Maastricht University, using a new paradigm of this century: biomanufacturing.[10] This new form of disruptive innovation breaks with traditional channels of conventional innovation to offer products that are completely original. This is meat made by cultivating muscle stem cells from live animals in a bioreactor. There can be no doubt that although industrial energy has biological effects by definition, using it appropriately will enable the production of more food while mitigating the resulting environmental harm, with less need for land use as pasture and hardly any water consumption, less greenhouse gas generation and no animal suffering.[11] It was approved for human consumption in Singapore in 2020,[12] and although it has yet to be commercialized, this new form of real meat may be in the market in 2021.[13]

There are yet more examples of disruptive innovation in hamburger manufacturing, especially for vegetarians and vegans. Beyond meat has been sold since 2013, and it is basically a meat-substitute made from a mixture of soy protein, pea protein, yeast and other ingredients. It mimics the shape, texture and taste of meat, and it is supported by its sustainable slogan ''Can artificial meat save the world?''.[14] Other examples are Beyond eggs, Beyond chicken and Beyond burger, the last of which contains 20 g protein, with no soya, gluten or transgenic ingredients. It is also cholesterol-free and contains half the saturated fat of a traditional beef hamburger. This product is promoted as animal-free and respecting the environment, and it has achieved the backing of institutions and people such as Bill

Gates, with unexpected stock market success.[15] Impossible meat is another example of innovative creativity, achieving an important success in metabolic engineering. This hamburger is sold in food shops and the Burger King chain in the United States under the Impossible Whopper name. It has the same taste, culinary and nutritional characteristics as traditional beef, but is lower in fat and cholesterol, as well as being free of animal products.[16] Its basic ingredients are texturized wheat protein, coconut oil and potato proteins. Haemo-rich material (leghaemoglobin) was used to achieve the same taste as beef, from a modified yeast culture transfected with a natural gene from the roots of leguminous plants which functions as a myoglobin analogue. The resulting product has the typical taste and culinary characteristics of beef. As a whole, it is calculated that replacing beef with plant-based products would reduce land use and water consumption by more than 70%, with a possible 67% fall in the production of greenhouse gases.[17]

Other less well-known but highly interesting sources of protein for human consumption are mycoproteins and those from insects. Of the first, Quorn, which is a protein with a texture similar to that of meat, is authorized for consumption in the United States and Europe. It is produced by *Fusarium venenatum* fungus, which is able to produce a large amount of biomass. The fungus is cultivated in fermentation tanks, and once a suitable amount has been produced it is extracted and the protein is purified, representing 42% of the biomass of the microorganism. It is also rich in fibre and low in fat, cholesterol, sodium and sugar, so that it can help to maintain cholesterol and glucose levels, increasing satiety. Very rare allergic reactions to this protein have been described, and consuming it would give rise to a major environmental benefit.[18] An industry is also rising around insect proteins, as this attracts many investors due to their important nutritional perspectives for human and animal food, as well as medical products and fertilizer. One of the most attractive examples is the yellow mealworm *(Tenebrio molitor)*, which is economically highly profitable if used in the large-scale conversion of plant biomass into proteins, as well as the possibility of achieving sustainable production.[19] In January 2021 the European Food Safety Authority (EFSA) published its scientific opinion on the dry extract of this mealworm, recognising the new food as safe for human consumption.[20]

Interest in environmental sustainability and reducing residues

In previous chapters we underlined how many innovations are supported by their benefit in terms of environmental sustainability. It is therefore necessary to have a new and recommendable dietary model based on these innovations as well as other traditional products which respect human and planetary health. Although consumers already considered this interesting, their interest has increased since the start of the COVID-19 pandemic. A 2020 report showed that 60% of individuals were developing more sustainable and ethical shopping habits, and that 9 of every 10 started that they would continue to do so after the pandemic.[21] It has been known for years that the food sector is one of the main causes of global heating, causing more than 22% of world production of greenhouse gases, making it a key factor in global heating. Furthermore, 80% of the said effect can be attributed to the cattle farming sector, including feed and transport.[22] In 2015, the conclusions of a commission that included the Rockefeller Foundation and the Lancet journal were published, warning that the concepts of health, which is usually applied to individuals, communities, populations and nations, does not take into account the fact that human health is achieved at the cost of eroding the natural systems of the planet that civilization depends on. Unsustainable exploitation will therefore negatively affect present or future populations, so that environmental well-being and human well-being and health should go together.[23] There is also evidence that malnutrition in all of its forms, including the two constantly growing pandemics of obesity and sub-nutrition, are not isolated events but are linked to global heating and climate change. However, the interesting fact here is that there is such a strong interaction between three problems that it is impossible to resolve any one of them without covering all three.[24] These facts have led the most important researcher into the relationship between health and the Mediterranean diet, Walter Willet, to consider that foods are the strongest lever in optimizing human health and the environmental sustainability of the Earth. He proposes a new form of diet that would be healthy for humans as well as the planet, based on the production of sustainable foods in what he terms a ''healthy planetary diet'', the best example of which, according to his report, is the Mediterranean diet.[25]

The diet we recommend in a few years' time should therefore be based more than now on foods with a vegetable origin, with a variety of fruit, greens, nuts, pulses and whole grain cereals, reducing the consumption of meat, dairy products and most especially red meat produced in an unsustainable way. This will prevent 11 million premature deaths per year, and it will ensure that a healthy diet will be available everywhere on the planet in 2050. This diet should be flexible and adaptable to all of the geographical conditions of each population, their own culinary traditions and personal preferences. A practical, arduous and complex task will be necessary for this: the application of the said recommendations to our own context, in a simple and effective way. Fig. 1 shows the composition of the proposed diet, expressed in grams consumed per day.[26] We will base ourselves here on the Mediterranean diet, which should be adjusted to fit the global model, increasing vegetable products and reducing traditionally-produced animal protein. Nevertheless, innovation in agriculture and food will also have to resolve certain important problems, one example of which is fish consumption. This is unsustainable in its current form of production, as apart from the exhaustion of fishing grounds and species loss, it generates large amounts of greenhouse gases, especially by trawling and recirculating fish farms. In fact, a study by Tilman and Clark found that the Mediterranean diet was a major cause of greenhouse gas generation that was only surpassed by the omnivorous diet, largely because of fish consumption.[27] More efficient forms of production will therefore permit higher consumption.[28] Another example is the current degree of tolerance in recommending white meat consumption, such as fowls, and lean red meat. Both of these types of meat have a highly negative impact on sustainability. Initiatives such as cellular

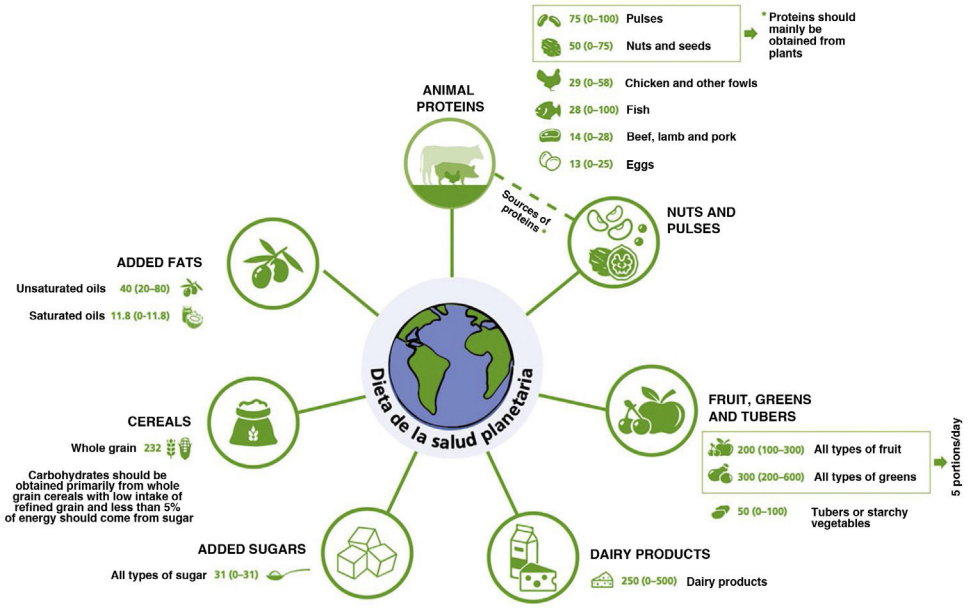


Figure 1 The ingredients that a planetary diet that is healthy for human beings and the planet should contain. Amounts are expressed in grams per day. Source: Pérez-Martínez et al.[26]

agriculture and other alternative ways of producing protein will give us an appropriate response.

Consumers will seek new tastes and experiences

After more than a year of restrictions on mobility, consumers want to try new products that broaden their range of tastes, with increasing restaurant-based tourism. Innovative companies will therefore bring new flavours and textures to our homes, with new foods and different ingredients. This is important, as these changes will usually involve food additives, and this is the Achilles' heel of new foodstuffs, as many of them are highly processed. According to the Spanish Agency of Food Safety and Nutrition (AESAN), se foods of this type are made using a very wide range of ingredients, with additives (natural and synthetic) that have the aim of extending their useful life, making them enormously more appetising and acceptable for consumption. Such foods would hardly be recognisable in their original state.[29] Additives are widely present in highly processed foods, as they are not solely to aid preservation and make them safe to eat. Many ingredients are added for fundamentally commercial reasons, and these include ingredients that imitate or enhance flavours and ones that eliminate undesirable qualities from the finished product, colouring agents, flavourings, sugar-free sweeteners, emulsifiers, chelating agents and others. In fact, highly processed foods often have a significantly higher content of saturated fats, sugar and salt than those which are only moderately processed or unprocessed, together with lower nutrient density and higher energy density.[30] Consuming such foods to excess therefore gives rise to a high health risk, most of all considering that in Spain consumption of them is rising. Their link to the obesity epidemic in our population has been demonstrated by observational studies.[31] However, their inclusion in diet is also associated with many other diseases, including metabolic syndrome, type 2 diabetes mellitus, cardiovascular diseases, fatty liver disease, arterial hypertension, cardiac diseases, cerebral vascular accidents, cancer, irritable bowel, depression, dementia and other causes of mortality.[7] Innovation is required to resolve these problems, by designing ingredients that are harmless and safe, while keeping those that are fundamental for food conservation and safety. An example of such innovation is the work to create safe sweeteners with a natural origin, to replace the artificial sweeteners currently used, as they may contain potential health risks.[32]

Conclusions

1 Traditional diets are gradually being abandoned, as diet is increasingly globalized and based on new processed and ultra-processed products.
2 Technological innovation is creating new disruptive foods, with the aim of broadening the offer of nutrients for a growing population and to counteract global heating.
3 Medical professional should redefine and scientifically evaluate a new form of diet, one that is healthy for the planet as well as for present and future generations.

Conflict of interests

The author has no conflict of interests to declare.

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