Ultra-processed Foods

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Ultra-processed foods were first defined by Dr. Carlos Monteiro in 2009 through the NOVA classification. Briefly, they are characterized in their formulation by the addition of cosmetic ingredients and/or additives for mainly industrial use - and having undergone an excessive processing - to imitate, exacerbate, mask or restore sensory properties (aroma, texture, taste and color). It can also be very denaturing technological processes directly applied to the food (cooking-extrusion, puffing, etc.). They are food and drink products that have undergone specified types of food processing, usually by transnational and other very large 'Big food' corporations. These foods are designed to be 'convenient, eaten on the go, hyperpalatable and appealing to consumers, and, most importantly, the most profitable segment of Big Food companies' portfolios because of these foods' low-cost ingredients'.

The NOVA-derived Siga score propose a complementary definition more focused ont the degradation of the food/ingredient matrix effect: "An ultra-processed food is characterized by the presence in its list of ingredients of at least one substance that is itself ultra-processed, called a marker of ultra-processing (MUP). These MUPs are obtained by synthesis, or by a succession of physical, chemical and/or biological processes applied to natural raw materials and which lead to a strong degradation compared to their original matrix".

Keywords: Ultra-processed foods ; NOVA and Siga scores ; Human Health ; Food system sustainability ; Extreme reductionism ; Matrix effect ; Artificialized/hyperpalatable matrices

1. Introduction

Since 2009, the concept of ultra-processed foods (UPFs) has rapidly emerged and is now recognized and used by both public institutions (e.g., Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), Pan American Health Organization (PAHO), United Nations Children's Fund (UNICEF), and The World Bank) and academic researchers worldwide [1]. In brief, within the proposed NOVA classification of four technological groups, UPFs belong to NOVA group 4 and are notably described in the 2014 Brazilian Dietary Guidelines [2]. They are characterized as having undergone excessive processing and containing additional 'cosmetic' ingredients and/or additives of primarily industrial use to mimic, exacerbate, mask or restore sensory properties (aroma, texture, taste and colour) [3]. In other words, UPFs are artificial foods with organoleptic and sensory properties modified by the addition of 'cosmetic' additives and/or highly processed ingredients. Therefore, UPFs are supplying to human organism new unstructured and recombined food matrices, but also new ultra-processed ingredients and additives [4], and whose health effects still needs to be studied on a long term. They are also the reflection of the last nutritional transition that occurred as a major event in the 1980s in Western countries.

The processing of foods is very important for ensuring food security and safety [5]. For a long time, the security and safety of food have been ensured by salting, drying, smoking, sugaring, pasteurizing, or fermenting. At present, numerous additives, namely, preservatives and antioxidants, are also used. Their use makes it possible to preserve foods during long periods of transport in trucks or boats from a production site to supply megalopolises worldwide and to help typical consumers cover, for example, seasonal gaps or if food storage at the household level is poorly managed. Therefore, to feed humanity, food processing is essential. In addition, some foods require processing to be palatable (e.g., grains), safe (e.g., pasteurized milk), or available year-round (e.g., canned, dried, and frozen fruits and vegetables) [6]. Processed foods, especially those of recognized multinational brands, in developing countries have a modern image.

Importantly, improvements have been made in addressing food toxicity, notably in developed and emerging countries. However, food nutritional security has deteriorated, as seen from the triple burden of malnutrition that affects all countries worldwide, i.e., under- and over-nutrition and nutritional deficiencies[7]. In particular, over-nutrition has led to explosions in the prevalence of chronic diseases. In 2016, the World Health Organization (WHO) estimated that approximately 650

million adults were obese[8]. According to the same estimates, the rate of type 2 diabetes, currently at 9%, is projected to rise by three percentage points over the next 25 years[9]. Additionally, excess body weight affects over two billion people worldwide[10]. Chronic diseases have progressively replaced infectious diseases.

UPFs are made from many recombined ingredients and/or additives, and we suggested that the link between UPF and food system sustainability is first driven by the massive production of these compounds. This question is addressed by identifying the ingredients/additives characteristic of ultra-processing within the list of UPF ingredients used in these products. Based on the UPF definition by NOVA, Figure 1 schematically represents the way in which a UPF is generally constructed, i.e., through the cracking of raw foods into isolated ingredients that are then recombined in artificial matrices with the addition of industrial 'cosmetic' additives that are not commonly used in the kitchen [1][11]. Depending on food products, e.g., ready-to-eat dishes, UPFs may also contain more or less real foods. The processes used to create these markers of ultra-processing include refining, extraction, purification, hydrolysis, and/or chemical modification. Such ingredients include processed carbohydrates such as sugar syrups, maltodextrins, dextrose, malt extracts and polyols, mainly extracted from maize, and wheat, rice, and potato; processed lipids such as refined and/or hydrogenated and inter-esterified oils; and processed proteins such as isolates from soy, milk, pea, egg, and meat, derived hydrolysates, and gluten. In addition to these ingredients, UPFs also contain "cosmetic" additives extracted directly from natural ingredients or chemically synthesized; there are more than 316 authorized at the European level and more than 2500 at the world level, as evaluated by the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

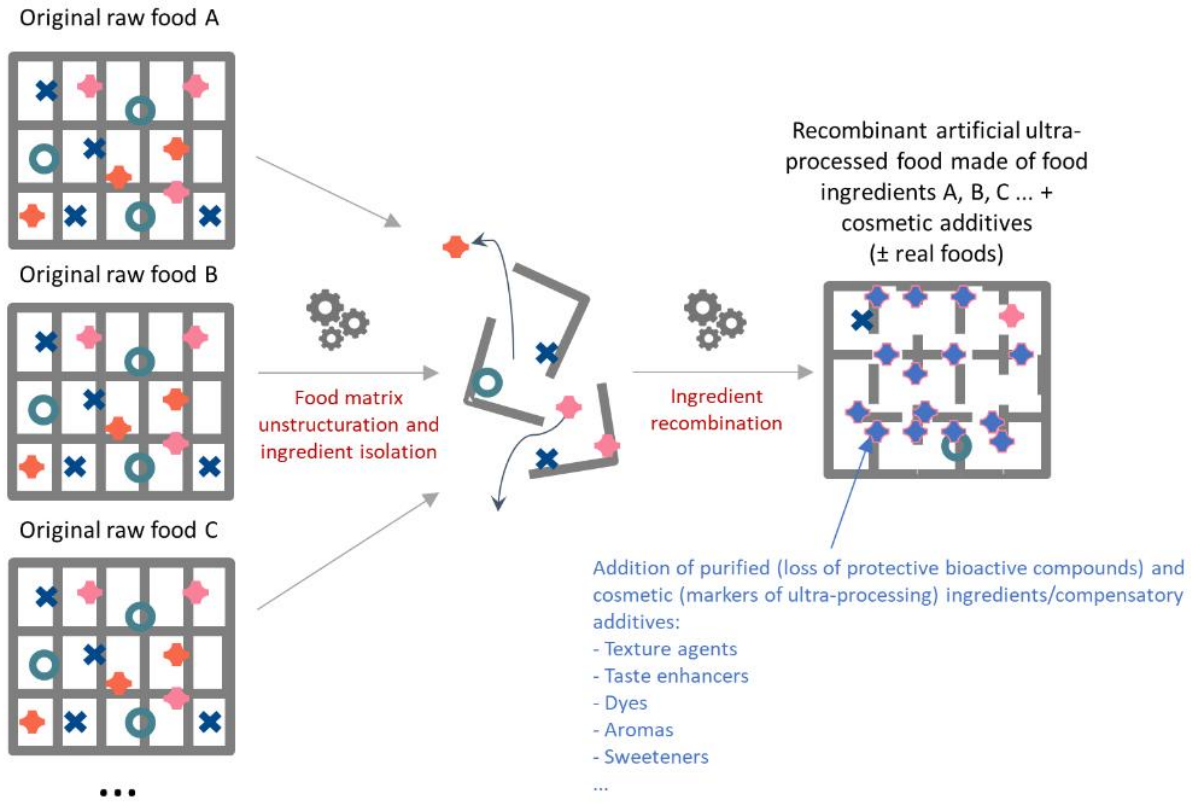

Figure 1. Schematic representation of UPFs through fractionation of original raw foods and ingredient recombination with 'cosmetic' additives. Figure was originally supplied by the Siga Society©.

2. Ultra-Processed Foods, and Cultural and Socio-Economic Dimensions

Beyond supplying nutrients and pleasure, diets are influenced not only by social/cultural traditions [12] (e.g., rice in Asia, cheeses in France) but also by religious traditions (e.g., vegetarianism in Hinduism) and socio-economic dimensions, including fair trade, the preservation of small farmers, and healthy food affordability [13]. Therefore, in this section, we addressed the links between massive production and consumption of UPFs, and culinary traditions, social life, and small farmers (Figure 2).

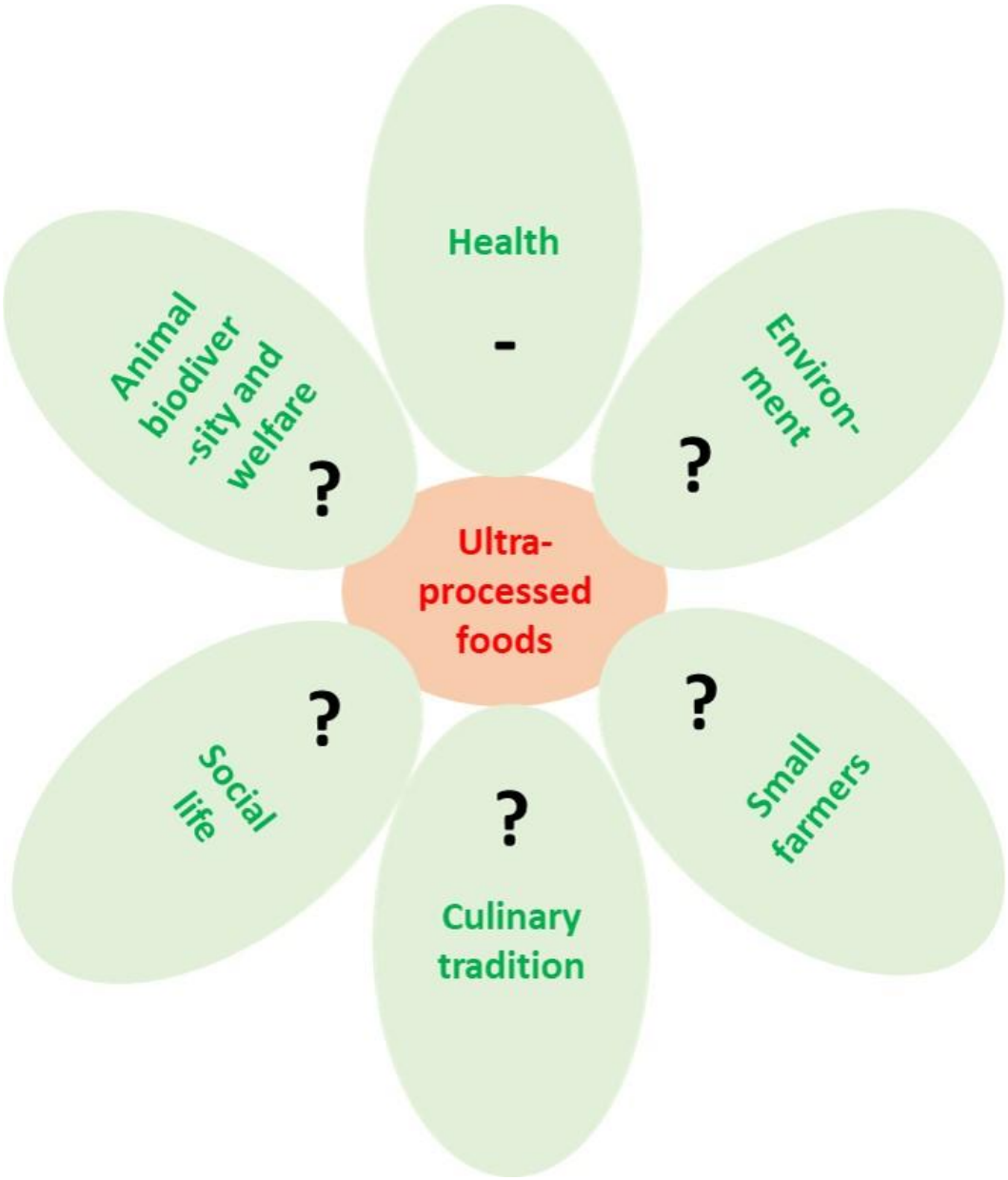

Figure 2. The potential impacts of ultra-processed foods (UPFs) on the six dimensions of food system sustainability

2.1. Ultra-Processed Foods and Culinary Traditions

Regarding social and culinary traditions, the Brazilian Dietary Guidelines warn about the loss of culinary habits in the confrontation of the country with industrialized and standardized products disseminated by means of intensive and aggressive advertising campaigns, leading consumers, particularly younger consumers, to consider genuine food cultures to be uninteresting [2].

If food standardization obviously allows strict and efficient toxicological and hygienic control, conversely, it is also a basis for ultra-processed and unhealthy foods. Indeed, the food safety paradigm has somewhat replaced food diversity and substitutes for healthier foods, as demonstrated in Western and emerging countries where consumers no longer die from food toxins but from chronic diseases and suffer from deficiencies because the empty calories from UPFs do not supply enough protective micronutrients (i.e., hidden hunger)[14][15].

Food standardization is also accompanied by standardized tastes worldwide [16][17]. Consequently, vacationers and travellers may prefer to buy UPFs abroad with no risk of disliking the product rather than testing a local dish with the risk of not liking it. The same is true for children, who are accustomed at a very young age to a standardized taste and who, upon reaching adulthood, reject real foods with subtler tastes. One can also observe that in numerous emerging and developing countries where the standard of living increases, this translates into the decline of traditional foods, i.e., there is a shift towards a certain homogenization of the way of eating, i.e., towards more animal and UPF calories, which are often considered outward signs of wealth [18].

However, if UPFs are very standardized foods marketed worldwide, there is also a tendency towards diet diversification due to world exchange [108]. At present, it is clear that several countries have access to a much higher food diversity than was available several hundred years ago, but this diversification has more to do with real or gastronomic foods than with UPFs. Moreover, the hyper-palatability of the latter increases the frequency of their consumption, to the detriment of traditional foods, resulting in a real addiction, as observed in obese children in Brazil [19].

2.2. Ultra-Processed Foods and Socioeconomics

Regarding social life, the Brazilian Dietary Guidelines [2] note that ready-to-consume UPFs, which can be consumed anytime and anywhere, "makes meals and sharing of food at table unnecessary", leads to the isolation of the consumer even if these foods "are disguised by advertisements suggesting that such products promote social interaction, which they do not".

Data reported in France and the USA showed that the highest UPF consumers had lower income and educational levels. Since higher UPF consumption is associated with a higher prevalence of obesity [20], this may be related to the well-known fact that lower-income populations in high-income countries often have higher rates of obesity and diabetes than do high-income populations in high-income countries [21].

Low-price, ready-to-eat, and highly attractive UPFs may also lead to a partial or complete substitution of local and traditional foods, especially in emerging and developing countries.

For example, in Africa, it has been observed that the import of chicken wings destroys local companies [22]. Indeed, the processing of slaughtering by-products into animal feed is prohibited for European poultry companies, and as a result, these countries export them cheaply to developing countries. This is only one example among others, e.g., excess milk in Europe is dried, defatted and exported to Africa, where it is cheaper than local milk.

As reported by Johnston et al.[13], the reason lies in the fact that "current government subsidies to farmers in the United States and parts of Europe enable developed countries to produce large quantities of cheap staple and ultra-processed foods at 40–60% below the cost of local production of similar goods in developing countries [23]. In turn, these less healthy foods as massive imports are considerably less expensive than the locally produced foods, distorting local markets and depressing demand for the more expensive, locally produced, and often times healthier food options [24]".

Therefore, the adoption of imported UPFs from developed countries may directly threaten small farmers in developing countries, who are then obliged 'to put the key under the door' and to feed the slums.

2.3. Conclusions

Overall, UPFs do not appear associated with a high level of social life, being consumed in isolated situations, e.g., in front of screens or on the move. On the contrary, real meals mostly made of real foods are associated with moments of festivity and family sharing. Due to their very low cost, some of them may also threaten small farmers and producers in many countries worldwide, especially in developing countries where local foods may be more expensive. In our developed societies, UPFs are generally more consumed by the poorest and less educated people, contrary to emerging and developing countries where they may appear as outward signs of wealth. Finally, through the high level of standardization, and their lower cost, many of them are progressively replacing some culinary traditions worldwide, especially among the youngest, such traditions appearing less attractive, with more subtle, risky, and demanding tastes.

3. Ultra-Processing, Environment, Biodiversity and Animal Welfare

UPFs appear associated with a poor level of biodiversity, notably due to the few plant and animal varieties that supplied the ingredients used for their production and processing. Moreover, intensive monocultures are very demanding in high input energy, and animal calories found in UPF are associated with high levels of GHGE, as well as deforestation with feed animals in intensive conditions, that are otherwise far from respecting their basic needs and wellbeing. In addition, fractionating raw foods into massive amounts of ingredients for producing UPFs all around the world appears more energy demanding than locally consuming raw or minimally processed foods. Plant-based UPFs are clearly not so energy demanding than animal-based UPFs, but they are not yet associated with a better food system sustainability, especially regarding intensive monocultures. In the following section, we intended to go beyond agricultural and environmental considerations, and to analyse and discuss the impacts of massive UPF consumption on cultural and socio-economic dimensions.

4. Conclusions & Perspectives

On Figure 3, in reference to Figure 1 and based on the gathered data in scientific literature, are synthesized the potential links between excess UPF consumption and the alteration of the different dimensions of the food system sustainability.

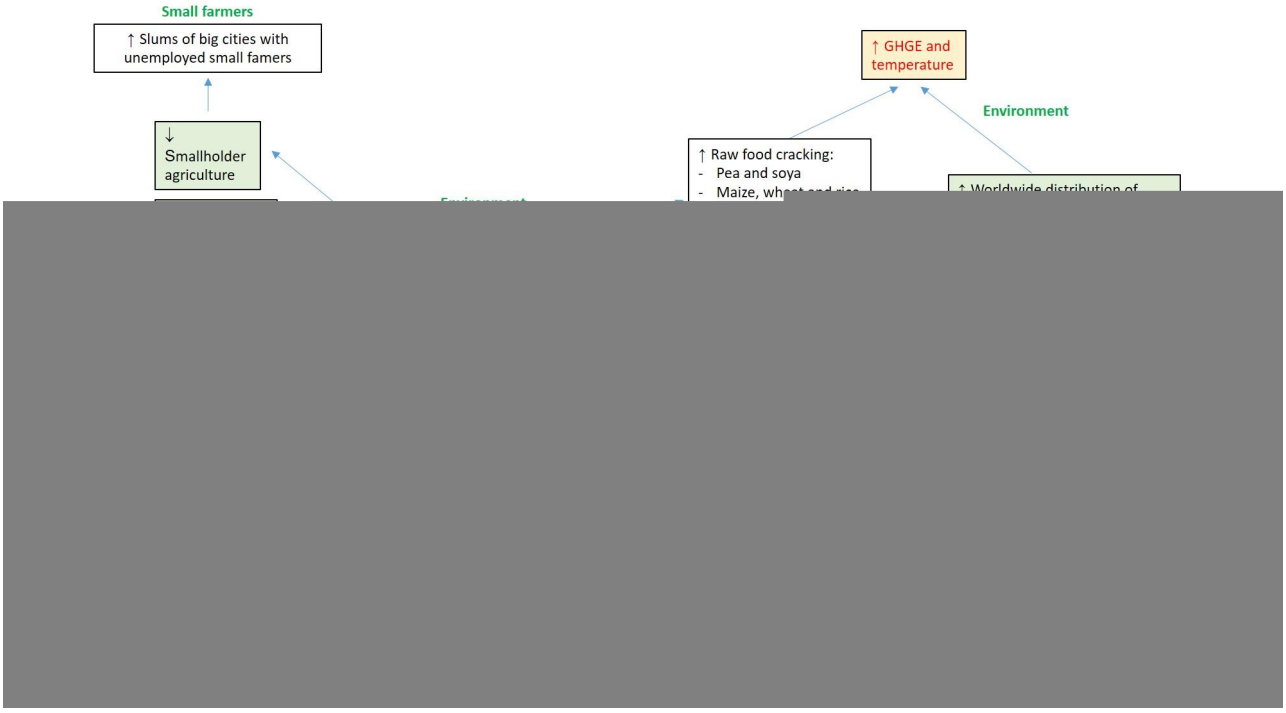

Figure 3. A summary of the impact of increased UPF consumption on food system sustainability

Overall, by combining both the low cost at purchase and increased consumption worldwide, most of these products appear potentially associated with intensive agriculture/livestock, a loss of culinary traditions, the progressive disappearance of small farmers/peasants, increased animal suffering, a loss of biodiversity, and social inequalities.

If agriculture is considered to produce too many GHGEs, future evaluations from farm to fork should further analyse the level of contribution of UPF processing, packaging, and transport. Similarly, when analysing the associations between food groups and GHGEs, it is important to discriminate the degree of processing of each of the foods included in those groups. Meanwhile, the available data appear sufficient to extend the application of the precautionary principle (applied to human health [25]) and to urgently implement policy regulations for agro-industrials to include nutritional and environmental criteria with regard to processed foods and policy incentives for consumers to shift from UPFs to real raw and mildly processed foods, preferably seasonal, organic and local products.

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