UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ZOOTECNIA E ENGENHARIA DE ALIMENTOS

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Processamento de Alimentos: Um estudo do comer e do papel da Engenharia de Alimentos no atual contexto mundial

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Processing food: A study of the eating and the Food Engineering's role in the current world context

Pirassununga
2023

Alessandra Amorim

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Versão corrigida

Dissertação apresentada à Faculdade de Zootecnia e Engenharia de Alimentos da Universidade de São Paulo, como parte dos requisitos para obtenção do título de Mestre em Engenharia de Alimentos do programa de pós-graduação em Engenharia de Alimentos.

Área de Concentração: Engenharia de Alimentos

Orientador: Prof. Dr. Paulo José do Amaral Sobral

Pirassununga

2023

Ficha catalográfica elaborada pelo
Serviço de Biblioteca e Informação, FZEA/USP, com
os dados fornecidos pelo(a) autor(a)

A524p Amorim, Alessandra Processamento de Alimentos: Um estudo do comer e do papel da Engenharia de Alimentos no atual contexto mundial / Alessandra Amorim; orientador Paulo José do Amaral Sobral. -- Pirassununga, 2023.
118 f.

Dissertação (Mestrado - Programa de Pós-Graduação em Engenharia de Alimentos) -- Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo.

1. processamento de alimentos. 2. Ultra-processado. 3. guia alimentar. 4. antropologia da alimentação. 5. segurança dos alimentos. I. Sobral, Paulo José do Amaral, orient. II. Título.

Às minhas sobrinhas, Maria Clara e Luiza, que me trazem a esperança de um futuro melhor.

AGRADECIMENTOS

Ao meu orientador, professor Paulo José do Amaral Sobral, que teve a coragem e sensibilidade de navegar por novos mares, com a resiliência, rigor e criticidade. Obrigada por me acolher, orientar, compartilhar conhecimento e experiências. Por confiar a mim um projeto inovador e complexo, tão prazeroso quanto desafiador e necessário. Obrigada pela paciência, por me mostrar o caminho e por ensinar muito mais do que Ciência, Tecnologia e Engenharia de Alimentos. Você é uma referência e inspiração. Serei eternamente grata.

Aos meus colegas do Laboratório de Tecnologia de Alimentos (LTA), pelas conversas, auxilio e parceria.

À Dra. Ana de Holanda Barbosa, do IPEA (Instituto de Pesquisa Econômica Aplicada), pela proatividade e sensibilidade ímpar. Sua parceria e conhecimento compartilhado foi essencial ao desenvolvimento dessa Dissertação. Nenhuma palavra aqui será suficiente para agradecer e descrever o quão grandioso foi tê-la neste projeto. Sua parceria foi um grande presente.

À também inspiradora Dra. Livia Barbosa, por disponibilizar seu preciosíssimo tempo e conhecimento. Sem as suas orientações, eu não teria a confiança e o rigor necessário para trazer aos profissionais da Ciência, Tecnologia e Engenharia de Alimentos temas tão importantes como Sociologia e Antropologia do Consumo. Suas publicações e conselhos enriqueceram essa Dissertação. Foi uma honra saber que a “Livia” era a “Barbosa”.

Ao professor João Borges Laurindo, da Universidade Federal de Santa Catarina (UFSC), pelos conselhos, parceria, olhar crítico, atento e humano. Pela coragem e disposição em embarcar com a gente neste desafio complexo e polêmico.

À professora Vivian Lara, pela sua energia, solicitude, orientação, paciência e sensibilidade. Sem você este projeto não teria a mesma qualidade.

Aos demais professores da FZEA-USP, que participaram da minha formação e me incentivaram no desenvolvimento desta Dissertação. Em especial ao professor Rodrigo Petrus, pela inquietude e proatividade diante dos atuais desafios.

Aos meus pais, familiares e amigos, que me ensinam e me motivam a ser uma pessoa melhor.

À Faculdade de Zootecnia e Engenharia de Alimentos (FZEA) da Universidade de São Paulo (USP), pela estrutura e formação.

À Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) pela concessão de bolsa para o desenvolvimento desta Dissertação – Código de Financiamento 001.

Ao CNPq e à FAPESP por financiarem meu orientador.

“Do not look the other way. Do not hesitate. Recognize that the world is hungry for action, not words. Act with courage and vision.”

Nelson Mandela

RESUMO

AMORIM, A. **Processamento de Alimentos: Um estudo do comer e do papel da Engenharia de Alimentos no atual contexto mundial**. 2023. 118 f. Dissertação (Mestrado) – Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, Pirassununga, 2023.

Em meio a ondas de desinformação e equívocos conceituais relacionados ao processamento de alimentos, esta Dissertação teve como objetivo fazer uma análise histórica, antropológica, social e econômica do comer, destacando a importância da Ciência, Tecnologia e Engenharia de Alimentos (FSTE) na construção das sociedades atuais, bem como reivindicar por diálogo multidisciplinar na construção dos guias alimentares. Trata-se de um estudo das fronteiras entre a Engenharia de Alimentos e outras áreas do conhecimento. A análise se baseou numa vasta e crítica revisão bibliográfica a partir de palavras-chave de cada área em questão em bases de dados como Web of Science, Scopus, Pubmed, dentre outras, bem como em livros de autores reconhecidos em cada área. Os resultados foram apresentados em três capítulos: (1) Análise holística sobre a visão histórica e antropológica atreladas as decisões de consumo, bem como sua relação com a cadeia de suprimentos, órgão reguladores e entidades públicas; (2) Estudo do papel da cadeia de suprimentos e do conhecimento técnico-científico na segurança dos alimentos e alimentar, refletindo seu impacto em questões de políticas públicas (garantia de acesso longevo ao alimento de qualidade) e privadas (tendências e adaptações às demandas do consumidor), ressaltando a necessidade de diálogo e esforços transdisciplinares; (3) Discussão crítica sobre a importância dos guias alimentares (FBDG) como ferramenta de política pública, considerando, além de saúde, questões humanitárias, sustentabilidade e estratégias de comunicação. Com as sociedades mais atentas às questões de saúde, ética e meio ambiente, tem crescido a busca por produtos mais saudáveis, sustentáveis do ponto de vista tecnológico e ético do ponto de vista moral, mas que permaneçam saborosos e práticos para o consumo. No entanto, conceitos como “natural”, “processo”, “tradicional”, dentre outros, ainda não foram claramente definidos ou amplamente compreendidos. Além disso, termos como “ultra-processados”, equivocados do ponto de vista da FSTE, emergiram e estão no inconsciente popular. O acesso a alimentação saudável e sustentável é um direito universal e

constitucional. Para garantir este direito, trabalhos inter e transdisciplinares, com união e diálogo entre as áreas se faz necessário.

Palavras-chave: processamento de alimentos, alimento ultra-processado, guia alimentar, antropologia da alimentação, segurança dos alimentos, segurança alimentar.

ABSTRACT

AMORIM, A. **Processing food: A study of the eating and the Food Engineering's role in the current world context**. 2023. 118 f. M.Sc. Dissertation. Faculdade de Zootecnia e Engenharia de Alimentos, Universidade de São Paulo, Pirassununga, 2023.

Among the current waves of misconceptions, misinformation and mistakes about food processing, the objective of this Dissertation was to make an historical, anthropological, social and economic analysis of the eating, highlighting the importance of the Food Science, Technology and Engineering (FSTE) in the current framework of society, as well as to call for a multidisciplinary dialogue when building food guidelines. The scope includes the frontiers of Food Engineering and related fields of food knowledge, and it build points with references strategically drawn from a wide range of key-word databases, such as Web of Science, Scopus, Pubmed, e.g., and literature by recognized authors. The results were organized into 3 chapter topics: (1) A holistic analysis about the historical and anthropological viewpoint, which can be connected with the decision of consumption as well as its relation with the food supply chain (FSC), regulatory bodies, and political entities; (2) The study of the role and duty of FSC functions and the technic-scientific knowledge in food safety and food security, and its impact on public policy (long-term quality food security) and the private sector (consumer trends and adaptations to the demands), which highlights the necessity of dialogue and trans disciplinary efforts; (3) A critical discussion about the importance of the Food-Based Dietary Guidelines (FBDG) as a public policy tool, also considering sustainability, humanitarian issues and communication strategies, in addition to health aspects. Given the current heightened awareness about health, ethics, sustainability, and the demands for healthier, ethical and environmentally friendly products, but that keep food tasty and practical to eat, consumer expectations have risen to a level of multidimensional desires. Nevertheless, concepts such as "natural", "process", "traditional", to name but a few catchwords, have not been clearly defined or are widely understood. Most notably, concepts such as "ultra-processed food" are misleading from the FSTE point of view, and such logic has emerged and become embedded as unconscious public opinion. Sustainable and healthy food access is a universal right, and inter and trans disciplinary work for dialogue and union among the associated areas of disciplines is now necessary for progress.

Key-words: food processing, ultra-processed food, food guideline, food anthropology, food safety, food security.

Sumário

GENERAL INTRODUCTION

The Food Based Dietary Guideline (FBDG) is a science-based recommendation in the form of guidelines to improve health through food choices (ARANCETA-BARTRINA et al., 2019; HERFORTH et al., 2019; FAO/WHO, 1998). The first FBDG was created and proposed in Sweden at the end of 1960's, and it was followed by other European countries in the 1970's and 1980's (RONG et al., 2021); however, it was only in 1996 that the FAO/WHO joined in a meeting of experts and published a reference document to orient countries for developing their FBDG (FAO/WHO, 1998; RONG et al., 2021). The overall purpose of the joint FAO/WHO action (1998) was to promote a public policy tool to "improve the food consumption patterns and nutritional well-being of individuals and populations", and, more specifically, "to review the scientific evidence and epidemiology of diet related health forms, including non-communicable diseases and others forms of malnutrition", that can be used by individual members (breastfeeding, children, eldering, indigenous, e.g.) or general population (FAO/WHO, 1998).

This public policy tool, which also requires cultural acceptability, has to be appropriated for the region or country, and be easily adoptable (ARANCETA-BARTRINA et al., 2019; MONTAGNESE et al., 2015, 2017; HERFORTH et al., 2019; FAO/WHO, 1998). The FAO/WHO joint action (1998) also encouraged to extend the orientations of other policies related to health, such as physical activities, alcohol consumption and smoking, which has been followed by the Italian, French, Argentinian, Australian, and Chinese FBDG's, regarding to alcohol, British and Indian FBDG's to tabaco, and Spanish FBDG's to physical activity, for example. Furthermore, this transversal FBDG approach has opened doors for sustainable diet concept. According to the FAO (2022b), the "sustainability of diets goes beyond nutrition and environment as to include economic and socio-cultural dimensions". It is a consensus that the global warming consequences on food production will especially impact economically disadvantaged populations. The "sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations" (FAO, 2022b).

Notably, to achieve sustainable diet is mandatory the implementation of sustainable food systems (ARANCETA-BARTRINA et al., 2019), and it includes the Food Supply Chain (FSC) and their actors (DESIDERIO et al., 2022; KUMAR et al.,

2022; ARANCETA-BARTRINA et al., 2019). In this way, any public tool that involves food quality access must include the Food Science, Technology and Engineering (FSTE) scholars. The development of the FBDG is generally made by health professionals (FAO, 2022a). Recently, the Brazilian FBDG adopted a food classification according to NOVA classification, which categorize foods in four groups (MONTEIRO et al., 2019): 1) Unprocessed and Minimally Processed foods; 2) Processed culinary ingredients; 3) Processed foods, and 4) Ultra-processed foods. However, the main criterion of the NOVA classification is associated to the product ingredients but not linked to any food processing actions (SADLER et al., 2021; PETRUS et al., 2021; KNORR and WATZKE; 2019; KNORR and AUGUSTIN, 2021), and this demonstrated a total lack of knowledge about the FSTE concepts (PETRUS et al., 2021). Moreover, in addition to mistakenly mixing formulations with processes (KNORR and WATZKE, 2019; BOTELHO et al., 2018; JONES, 2018; CARRETERO et al., 2020), the NOVA classification incorrectly gives a pejorative meaning to industrialized food (PETRUS et al., 2021; KNORR and WATZKE; 2019), and even further, it completely overlooks food safety issues and supply chain operations importance, and it does not consider any food safety or security matters. Given these oversights, the Brazilian FBDG should be revised in terms of the shortcomings of its food classification system and bridges across food experts need to be considered (FAO, 2010).

This Dissertation describes the theoretical studies in the frontiers of Food Engineering and other public food management. Methodologically, this study was based on a wide and critical literature review from key-words in databases such as Web of Science, Scopus, Pubmed, e.g., and works of recognized authors and authorities.

The innovative approach to research herein was born of necessity to demystify and critically explore and discuss beliefs and misconceptions about food processing and industrialized foods. Food involves feelings, emotions, beliefs, and traditions. Food and culture are inextricably linked (BARBOSA and CAMPBELL, 2006). Moreover, food consumption is integrally related to health, quality of life, moral values and longevity (POULAIN, 2017; MONTANARI, 2004), and the goal to assure food access must certainly be symbiotic with the urban lifestyle as much as others. The food industry has rapidly developed, and lifestyles are changing. Food habits are not static (MACIEL, 2004); however, historically, diet change has occurred over a long period of time, which did not happen with after the industrialization age. To make this reality even more

complex, scientific knowledge and technological improvements are still occurring, albeit ever more rapidly, and the constant search for new discoveries can provoke insecure feelings and sensations of fear in populations.

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CHAPTERS DESCRIPTIONS

This Dissertation is composed of three chapters, in which two chapters correspond to published articles in the revue **Frontiers in Nutrition** and the other has been submitted recently to the **Journal of Cleaner Production**, as following:

In Chapter 1: Amorim, A., Laurindo, J. B., Sobral, P.J.A. On how people deal with industrialized and non-industrialized food: A theoretical analysis. **Frontiers in Nutrition**, v. 9, 948262, 2022.

In Chapter 2: Amorim, A., Silva, V. L. S., Sobral, P.J.A. Food Processing: An overview on links between safety, security, supply chains, and NOVA classification. **Journal of Cleaner Production**, 2022. Submitted.

In Chapter 3: Amorim, A., Barbosa, A. H., Sobral, P.J.A. Hunger, Obesity, Public Policies, and Food-Based Dietary Guidelines: A Reflection Considering the Socio-Environmental World Context. **Frontiers in Nutrition**, v. 8, 805569, 2022.

The chapter 1, which corresponds to the article "On how people deal with industrialized and non-industrialized food: A theoretical analysis", aimed to propose a reflection about the borderland between Food Science, Technology and Engineering (FSTE) and Anthropology through considering mainly social and historical aspects. In this chapter, concepts such as food and meal are discussed from the viewpoint of FSTE scholars and people in general. Concepts such as industrialized, traditional and artisanal foods, food services (e.g. fast food, restaurants) and junk food were also explored. Additionally, a reflection about food as cultural habits and social interactions were discussed that showed the relevance of some feelings and beliefs that surround the eater/customer in their dietary decision making, and issues such as neophobia, neophilia and orthorexia nervosa were examined. Moreover, this chapter reflects on food from the viewpoints of some mystical and symbolic views that are expressed in terms of philosophies of life (vegetarianism and its derivations – veganism, flexitarianism, and others) and religions, which can culminate in the concept of so called food politicization that can transform food beliefs into more expressive behaviors of activism. All of these elements are inherent in foods and strongly impact the relationship among customers and the food supply chain members (producers, processors, services, for example, i.e., FSTE professionals), regulatory bodies, and political entities. FSTE professionals work to

satisfy customers; however, this objective must be achieved according to real world levels of understanding and a level of excellence that meets sociological and anthropological expectations. To be sure, mastering all the aspects of technology is required and extremely important, but it is not enough.

In chapter 2, the discussion considers that consumer viewpoints must be incorporated by the FSTE professionals as consumer trends and are the main drivers for industry innovations. Thus, this chapter, corresponding to the article "Food Processing: An overview on links between safety, security, supply chains, and NOVA classification", embraces the social and health improvements that the food industry has brought in the areas of food safety and security (which was ignored by NOVA classification) as well as asks for more dialogue and synergy among different fields of knowledge, especially those of the FSTE, health and social sciences professionals, and policymakers. In addition, this chapter also tries to demystify some beliefs that involve the quality of processed, non-processed, industrialized and homemade foods as well as local production and shorter supply chains. The public policy sector has the duty to guarantee quality food to every single person, i.e., their assurance for nourishment and safe food over the long term. The private sector, in turn, which is represented by the FSC members, are able to produce and transport food in sufficient amounts with adequate quality and safety controls; however, making food access an amply reality is complex and both sectors must work together. The food system, despite having promoted important social improvements, is not perfect and changes are needed, starting with transparency and sustainable choices. All food scholars have the same goal: promote health and quality of life to the population through food, and, given this, fostering more dialogue and united action among other public food managers are crucial.

In the 3rd and final chapter, "Hunger, obesity, public policies and food-based dietary guidelines (FBDG): a reflection considering the socio-environmental world context", the important roles of the FBDG as a public policy tool, in communication strategies, and for sustainability and humanitarian points point of view were discussed. In this chapter, the concepts of food processing (minimally processing, processing and ultra-processing), food loss and waste, malnutrition, traditional food knowledge (including social matters such as women entering into the labor market, food away from home and food at home, e.g.), and the role of economy, FSC and governments in the healthiness and sustainability matters are all presented. To achieve sustainability through

diets, the policymakers, the FSTE, agricultural and health professionals should work together to contribute to the development of efficient and effective public policies.

Throughout all three chapters, some beliefs about food processing and quality are discussed through the lens of: (1) anthropology; (2) FSC, and (3) FBDG, always highlighting social and economic issues and including important food safety, security and supply chain perspectives.

Moreover, it is necessary to emphasize that all human food is processed and that this processing is ongoing at the industrial, home, restaurant or food service levels. Notably, it should be recognized that campaigns against the food industry have emerged that are ignoring social and humanitarian improvements proportioned by them, such as increase in food production and access that is available at affordable prices. Throughout these three chapters, this Dissertation promotes the value of Food Science, Technology and Engineering knowledge that complement the development of society as well as identifies points that must be improved. The FSTE professionals and the food industry are now challenged to reinvent themselves by considering social and environmental drivers. To achieve healthiness and sustainability, a multidisciplinary work is required, and it must include the FSTE professionals.

GENERAL OBJECTIVE

The main objective of this Dissertation was to make an historical, anthropological, social and economic analysis of the eating, highlighting the importance of the Food Science, Technology and Engineering (FSTE) in the current framework of society, as well as to call for a multidisciplinary dialogue when building food guidelines.

CHAPTER 1

On how people deal with industrialized and non-industrialized food: A theoretical analysis

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Published in Frontiers in Nutrition, v. 9, 948262, 2022.

1.1. Abstract

"Canned, frozen, processed, ultra-processed, functional" etc. Two hundred years after the beginning of the food industry, industrialized food has evolved with many labels. Every person in the world eats and has different experiences with food that are connected to culture and social relationships which permeate our daily lives in many kinds of situations. Food evokes feelings, beliefs, desires, and moral values. For many people, food not only satisfies hunger and sustains life, but it also brings a delicious pleasure that is with their history, culture, and ancestry. Today's food industry pushes products through its marketing, which promotes a plethora of claims that have now trended proportionally with neophobic dimensions. In reality, the general public lacks objective knowledge about the complex science of modern food technology because of its low transparency, and this has resulted in the appearance of misleading ideas that can prejudice the correct analysis of food values. Given this, education about food is an urgent need. Notably, food scientists, technologists, and engineers must look at eaters through the prism of consumers who are human beings in all their rich social/anthropological diversity. The objective of this article is to explore the elemental anthropologic aspects of foods and how they can affect consumer's trust in the food industry's role.

Keywords: food industry, industrialized food, food-anthropology, neophobia, culture, FBDG.

1.2. Introduction

Food has always played an important role in humanity's development. It was an essential element during the cognitive, agricultural, scientific, industrial, and green revolutions. Since the Cognitive Revolution (circa 70 thousand years ago), *Homo sapiens* have been able to reflect, change and transmit knowledge to future generations, molding the social, economic, relational norms and values that created cultures (HARARI, 2015). In centuries past, especially during the Middle Ages and the colonization period, food was also an impetus for political, economic, and power upheavals (MONTANARI, 2004).

Fire has been frequently and exclusively used by *Homo sapiens* for about 300 thousand years to cook foods, and it is the most ancient thermal treatment (MONTANARI, 2004; HARARI, 2015). In the book "Sapiens, a brief history of humankind", Harari (2015) states that fire not only changed the molecular structure of

food by transforming it into products easily digested, but fire also altered biology and history. The variety of foods and the shortened time to eat and digest them, which fire "cooking" made possible, could explain the larger size of the human brain (CASCUDO, 1967), as well as its shorter intestine (HARARI, 2015; KNORR and WATZKE, 2019). Fire also powered the development and the diversity of cultures (LÉVI-STRAUSS, 1969). Omnivore feeding was transformed, and the human species went from insignificant animals to thinking beings that eventually dominated the planet and the other species, even though the *Homo sapiens* were not necessarily the physically strongest (HARARI, 2015).

Cooking, whether at home (using fire) or in the industry (using saturated water vapor) has been one the most ingenious resources invented by civilization (HARARI, 2015). It is the evolutionary act of manipulating and combining components to make food creations of does not exist naturally in nature, such as cheese, yogurt, sauces, pasta, cakes, etc. (MONTANARI, 2004). Industrialized food and the use of heat treatments increase the period of conservation and consumption of food (CONTRERAS and VERTHEIN, 2019) by reducing losses and preventing diseases (AMORIM et al., 2022), in addition to permitting more variety and diversity in the food choices.

This thermal treatment, i.e., the binomial time-temperature, is one of the main process parameters controlled in a thermal unit operation, which are used to transform all kinds of food into edible food and beverages (meat, grains, and vegetables, coffee, tea, etc.). Sometimes, "in home" or "by industry" processes are only used to change the texture, taste, and flavor of the food, such as stewed or boiled vegetables (FISCHLER, 1990). The application of this unit operation on an industrial scale is relatively recent. Indeed, wars stimulated the industrialized development of food almost 300 years ago. In the 18th century, Nicolas Appert was awarded by the French government for developing a food preserved method that allowed feeding troops during the Napoleonic Wars: The "appertization" (SILVA, 2020; SILVA et al., 2018; JONES, 2018; VERGARA-BALDERAS, 2016; FEATHERSTONE, 2012; SATIN, 2014; BOTELHO et al., 2018). Some years later, also in France, Louis Pasteur realized that the method developed by Nicolas Appert (heat application) was capable of reducing the microbiological population in food (SILVA, 2020; SILVA et al., 2018), which made food safe to consume and increased their shelf-life (that is, the time needed for food to rot) was-lengthened, and consequently, food was able to be safely preserved for consumption for a longer period.

Later, Nicolas Appert's and Louis Pasteur's experiments, complemented by the studies of Peter Durand's studies in England and Raymond Chevallier Appert's (Nicolas Appert's nephew) in France, opened the way to thermal treatments such as pasteurizations and sterilizations (Table 1) (SILVA et al., 2018), which are widely used today in the food industry for milk and meat products, tomatoes sauces, canned vegetables, etc. to reduce viable microorganism population into processed food.

Table 1. Industrial food thermal treatments.

	Pasteurization	Sterilization	Observations
Conventional	63-65 ºC/30 min.	121 ºC/21 min.	Applied with packaged solids or liquids foods. Continuous or batch process. Higher energy footprint.
High[1] and ultra-high[2] temperature	75 ºC/15 sec.	145 ºC/4-5 sec.	Applied with unpackaged liquid foods. Continuous process. Lower energy footprint.

1. High temperature, short time – HTST, 2. Ultra-high temperature – UHT.

Thermal treatment drastically reduced food poisonings and deaths from foodborne diseases by reducing the microorganism's population and this allowed expeditions from England to the Artic and the discovery of the Northwest Passage in 1819 (SATIN, 2014). Moreover, Europe had a history characterized by food supply chain crises and poisonings, so the possibility of safe food storage was viewed with an enthusiasm that propelled the development of the food industry and food sciences (SATIN, 2014; SCHNEIDER, 1979).

The age of the Industrial Revolution also saw the industrialization of artisanal and homemade foods on a large which allowed employee to stay a longer time outside home, including women (AMORIM et al., 2022; van BOEKEL et al., 2010; AGUILERA, 2006; FLANDRIN and MONTANARI, 2013). This facilitated a revolution in the Food Industry that, in turn, facilitated the migration of rural populations to the urban centers, which propagated many lifestyle changes. With these developments, women, who were traditionally responsible for domestic services, started entering into the labor market (AMORIM et al., 2022; POULAIN, 2017). Given less time for cooking at home, industry also developed labor saving adjuncts like special ingredients and convenience foods, domestic appliances, and read-to-eat food services such as restaurants (FLANDRIN and

MONTANARI, 2013). Although these lifestyle changes were not necessarily instilled by food industries, they did make a major contribution to support it.

During the 20th-century, food studies on the molecular level developed the knowledge of emulsion production and stability, the effect of water activity and glass transition in foods conservation, the use of bioactive compounds as food additives, hurdle technology, and new packaging systems, among others. Additionally, process innovations such as drying, extrusion, refrigeration, and freezing (SILVA et al., 2018; AGUILERA, 2006; BRUIN, 2003) were developed for products such as sauces, mayonnaise, ice cream, pasta, breakfast cereals, among many others (AGUILERA, 2006; BRUIN, 2003). According to Aguilera (2006), technological improvements and molecular studies on oils, fats, sugars, protein flours, and hydrocolloids have brought many applications to domestic and industrial food processing. Many products, flavors, and textures have been created and are now consumed around the world. Eventually, macromolecules have become nutrients, and this has led to food also claiming functional roles. Furthermore, the 20th century was also marked by the discovery and development of polymers, biopolymers, and food packaging improvements. Both at the industrial and domestic levels, today's foods can be consumed many days after preparation, thanks to processing, packaging and storage technologies based on scientific knowledge generated by a huge amount of high-quality research from Food Science, Technology and Engineering.

Although similar to homemade food, restaurants have the same function as the industry: to feed people that do not want or have time to cook (FLANDRIN and MONTANARI, 2013), but they do not have the shelf-life concern faced by the industry. The work routines in urban regions and the presence of restaurants (franchise or not) increased the population of those who eat outside home, which in the past was restricted mostly to workers during work time or on festive occasions. Nowadays, "eating out" is a more frequent as a leisure time enjoyed with family, friends, or alone (BARBOSA, 2010). With transport development, globalization and the food industry, people can move easily to different cities and countries. Regional foods crossed oceans and were introduced into other diets. Due to technological development, food can be consumed out of season elsewhere (POULAIN, 2017). For example, Chilean grapes are found in Brazil, and tropical fruits in Europe are available year round (FLANDRIN and MONTANARI, 2013). Although social and geopolitical concerns are still linked to food, thanks to the food industry and the leap in food production, eating is no longer a privilege but has

become a right (POULAIN, 2017). Nowadays, there is enough food production for everyone globally (AMORIM et al., 2022; POULAIN, 2017).

In light of the above, this article provides a brief critical review on food from a holistic viewpoint that reflects human consumption behavior and the eater/consumer relationship with the food supply chain (producers, food industry, and services), regulatory bodies, and political entities. Initially, the discussion will define food functionality in the sphere of relevant professional groups of Food Scientists, Technologists, and Engineers (FSTE) and those scholars responsible for the development of industrialized food. Next will be an examination of foods as social and cultural habits, followed by the different roles that foods hold for human beings, from both physiological and emotional points of view (hedonism, fearfulness, blame, and sense of security). This will include definitions of the industrial, artisanal and traditional foods in society and the understanding and acceptance of industrialized food by the eater/consumer. Finally, an additional reflection about food from mystical and symbolic points in terms of philosophies of life will be examined. It is essential to stress that each of these issues is complex and has been deeply discussed by anthropologists, sociologists, and psychologists in their domain of studies. Notably, this review has a transversal characteristic, in that the summary's focus proposes renewed direction by Food Science, Technology and Engineering (FSTE) professionals to go beyond the technical/economic points of view by focusing more on consumers as human beings. Further to this, the article ends by stating the need and importance for FSTE professionals to be included in all public health debates and classifications.

1.3. Is it food?

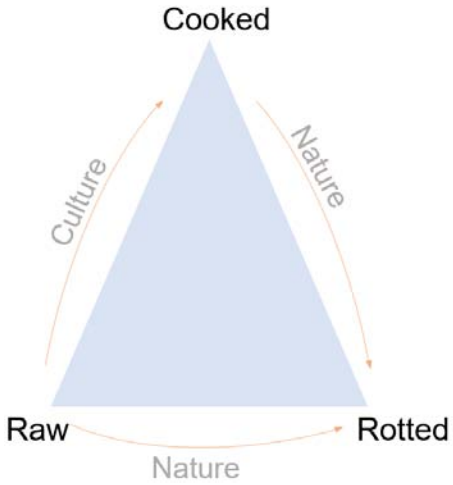
Eating occurs in cultural modes (BARBOSA, 2007; FISCHLER, 1988, 1990; MONTANARI, 2004; POULAIN, 2017; LÉVI-STRAUSS, 1969, 2013), and cuisine reflects the cultural, social, symbolic, economic, and history of a population (BARBOSA, 2007). Cooking is food's passage from its natural to its cultural state (LÉVI-STRAUSS, 1969, 2013; FISCHLER, 1988, 1990). According to Lévi-Strauss (1969, 2013), culture mediates the relationship between humans and everything surrounding them. To them, the kitchen has its own language, which changes according to society. In cuisine, food is not simply prepared; it is prepared in a specific procedure or another and demands a pan, the cultural element that represents civility. The cuisine defines the human condition in

all its attributes, even those that may seem “unquestionably natural” (LÉVI-STRAUSS, 1969).

In the “The Culinary Triangle” (Figure 1), Lévi-Strauss (2013, 1969) described that nature and culture are in opposed way mediated by the kitchen. In one aspect, raw food represents nature and is connected to cooked food by the culture which, in turn, finally returns to nature in its rotten condition. This concept has been changing nowadays, for example, the appearance of vegan diets and biological (“natural”) foods. In this way, FSTE plays a role similar to that of the kitchen with a better food cooking by controlling technical parameters of unit operations, additives and packaging contributing to prolongs food shelf-life as much as possible before it returns to its rotten condition. Because of food’s complexities and cultural values, this kind of change can generate identity conflicts for the eater/consumer (FISCHLER, 1990).

The decision to eat is also cultural (DWYER, 2021; GRACIA-ARNAIZ, 2021; HARARI, 2015, 2017; CONTRERAS and GRACIA, 2005; BARBOSA and CAMPBELL, 2006; MONTANARI, 2004). As processing food to provide energy and nutrients to keep the human organism functioning, the Homo sapiens developed many integrated patterns of human knowledge, beliefs, and behaviors about food that are learned, shared, and transmitted across generations, transforming food in culture (DWYER, 2021). Culture and consumption are not only interconnected but also inseparable. By helping to make sense of everything that surrounds *Homo sapiens*, culture determines and controls the criteria and distinction about what is acceptable, marketable and, therefore, capable of consumption (BARBOSA and CAMPBELL, 2006). In this way, individuals eat what is allowed and accessible to their cultures (GALINDO and PORTILHO, 2016; ROZIN, 1988; FISCHLER, 1990). People in Asian countries eat dishes prepared with insects (Indonesia, Thailand, Filipinas, etc.) and dogs (China and Korea). Italian and French eat snail and rabbit meat, while this is not common for Brazilians and British, although England and Brazil, among others, consume products from cattle, pigs, and poultry. These and many other rejections occur mainly because of moral aspects are at work in each culture (ROZIN et al., 1999). The dog is a life partner to the Brazilians and British, which does not occur with cattle (CONTRERAS and GRACIA, 2005), while in India, where the cow is sacred, it cannot be slaughtered and consumed as food (CASCUDO, 1967; FISCHLER, 1990).

Figure 1. The Culinary Triangle".



Source: LÉVI-STRAUSS (2013, 1969) with adaptations.

There is also a difference between the meal and food/foodstuff. Meals are connected to culture (BARBOSA, 2007; GALINDO, 2014; MONTANARI, 2004); however, FSTE understands food from a technical point of view. Food and foodstuff are the products that we can eat, being considered as food those processed at home, and foodstuff, those processed in an industry, independently of their degree of processing (KNORR and AUGUSTIN, 2021; KNORR and WATZKE, 2019; AGUILERA, 2018). This is what our evolutionary characteristics - dentition, jaw, and bowels - allow us to eat without representing risks to our lives. Nevertheless, some kinds of food can be eaten only after being processed (at home or industry), that is, as foodstuff: rice, beans, corn, potato, and cassava are not consumed as fresh food; however, they are excellent energy sources after cooking and/or processing. Similarly, some foods such as wheat, soybean, olive, and nuts, among others, are raw materials for foodstuff, which means that they are usually eaten only after more complex processing without necessarily using additives (PETRUS et al., 2020). Thus, to the FSTE professionals, a meal is what we eat, and food/foodstuff is what can be transformed into meals, independently of being classified as raw material, minimally processed, processed or ultra-processed foods, according to NOVA classification (MONTEIRO et al., 2019).

The FSTE professional deeply considers the microbiology, sensory and nutritional quality of raw material, water, ingredients, and final products for development. The focus is to attend to consumer needs by providing satisfaction, pleasure, and nutrition in safe

conditions (KOSTAROPOULOS, 2012; van BOEKEL et al., 2010). There is also the maintenance of the consumer´s quality of life, both from a health and lifestyle points of view. FSTE professionals aim to supply food to every person and all lifestyles around the world. To those who like to cook, the industry offers simple ingredients, such as salt, oils, flour, sugar, spices, etc., or more complex combinations such as emulsions, flours, sauces, meat, vegetable extracts, and milk cream, among others. On the other hand, there are convenience products for those who have practical lifestyles (KNORR and WATZKE, 2019; ORTEGA-RIVAS, 2010; FISCHLER, 1990). With industrialization, it is estimated that 80-90% of the ingredients and food used in home cooking are at least semi-processed by industry (van BOEKEL et al., 2010; SILVA, 2020). All this concern intends to satisfy the consumer, who is a human being shaped by his culture, full of feelings and insecurities. However, FSTE professionals do not explore anthropologic aspects, and this sometimes results in a weak connection between food processing developers and the consumer.

Human identity is built by memories, affection, sensorial experiences, and nostalgia (GALINDO, 2014). Some groups understand food as a product of rituals and traditions materialized during the cooking act. For them, food is more than a simple meal that provides energy and nutrients to the body, rather it is a symbol of their culture, ancestry and part of their identity (POULAIN, 2017; CANESQUI and GARCIA, 2005; FISCHLER, 1988), or in other words, it is performed by practices and relationships that are central to social reproduction (GRACIA-ARNAIZ, 2022). Some folks still believe that the feelings experienced from the act of cooking (including the feelings experienced by the slaughtered animals) can be passed on to the food, transforming it into a “blessed” or “cursed” meal. Therefore, from the cultural point of view, food nourishes and the meal has a “soul” (POULAIN, 2017; CANESQUI and GARCIA, 2005; FISCHLER, 1988). To some folks, industrialized food represents a threat to their cuisine tradition and the food cultural heritage (GALINDO, 2014; POULAIN, 2017; FISCHLER, 1988).

In the modern world, practicality can be an imposed necessity (GALINDO, 2014; FISCHLER, 2013). For some people, urbanization and industrialization have reduced the steps in cooking preparation and supplanted a pre-processed industrialized food, which has become separated from its natural origin as a commodity (POULAIN, 2017; GALINDO, 2014). Jean-Pierre Poulain, in his book “The Sociology of Food” (POULAIN, 2017), explains that, in a modern structural context, the individual loses his

role as an eater and becomes more of a consumer. Poulain also describes that the food industry has its roots in the familial cooking space, attacking its socializing function, without assuming it. Food and cuisine are elements of collective feelings and belongings (FISCHLER, 1990); although it is technically incorrect and without scientific evidence, it is possible to understand the origin of some expressions like “real food” to mean home processed food. These identity groups have difficulty accepting the inclusion of industrialized food in society due to their moral values and affective memories, which are rooted in their culture (POULAIN, 2017).

Food is identity (POULAIN, 2017; MONTANARI, 2004). It is even possible to recognize the individual’s personality traits throughout the elements that permeate their diet (FISCHLER, 1988). The cuisine is the last aspect that changed during the assimilation process (FISCHLER, 1990). FSTE professionals and the Food Industry as a whole aim to attend to the food demand of *Homo sapiens* with diversity. In this way, FSTE professionals should thoroughly understand the cultural aspects that permeate the eater/customer. In reality, the human being does not feed on complex molecules; most people feed on habits, rituals, knowledge, and sensations that this food represents (ROZIN, 1988). According to Claude Lévi-Strauss, food is not “good only to eat but is also good to think” (FISCHLER, 1988).

1.4. Food, culture, and social interaction

Eating is a way to communicate, and it is part of social relationships (BARBOSA, 2007, 2010; CONTRERAS and GRACIA, 2005; GALINDO and PORTILHO, 2016; LÉVI-STRAUSS, 1969). The act of eating together with others is typical behavior of *Homo sapiens*. The human being does not come together to eat and drink but to drink and eat together, socially, in an interaction act (MONTANARI, 2004). Eating is a complex phenomenon that includes biological, psychological and social aspects (POULAIN, 2017; FISCHLER, 1988, 1990; CÁCERES and ABAD, 2008; CANESQUI and GARCIA, 2005). More than a physiological need, food is associated with a sociocultural folk’s identity (MACIEL, 2004; FISCHLER, 1988; GALINDO and PORTILHO, 2016; CANESQUI and GARCIA, 2005; CONTRERAS and GRACIA, 2005; CASCUDO, 1967). Folk cuisine originates from a historical process and is loaded with singular traditions that, as belonging to a dynamic society, are constantly transforming and changing (MACIEL, 2004; SANTOS, 2008).

There is a distinction between eating (social action) and nourishing (biologic act) (FREITAS et al., 2008). Eating preference is not individual, and it is associated mainly with cultural aspects (FISCHLER, 1988, 1990; CANESQUI and GARCIA, 2005; CONTRERAS and GRACIA, 2005). Food consumption, in addition to nutritional requirements, is influenced by hedonism, moral responsibility, convenience situations (such as vacations, parties, and celebrations) (VERNEAU et al., 2014; CONTRERAS and GRACIA, 2012; CÁCERES and ABAD, 2008; CANESQUI and GARCIA, 2005) and lifestyle (likes, working/study hours, leisure time to shop, cook, eat and do the household chores) (CONTRERAS and GRACIA, 2012; FISCHLER, 1988; BARBOSA, 2007).

Eating is part of many temporal cycles, whether related to obtaining food (planting, harvesting, production, and availability). It can be fasting (characterized by the absence of food) or festive (when a lot of foods are allowed) (POULAIN, 2017). These biological and social aspects are marked by many interactions. Eating is the first step in human social learning (CONTRERAS and GRACIA, 2005), which evolves into more complex human relationships. Friendships, neighbor relations, and even politics also revolve around food (CANESQUI and GARCIA, 2005; BARBOSA, 2010). Sharing the meal, especially at home, is the first phase of the group association (MONTANARI, 2004). In childhood, as biological mechanisms emerge they are-modulated by these social aspects (breastfeeding, rest and work parent's time). As the child starts eating food in replacement of breast milk, the biological and the social merge to culturally adapt (POULAIN, 2017; CANESQUI and GARCIA, 2005).

The habits learned during childhood are modified throughout life, primarily as the outcomes of social interactions experienced at school and in professional environments, when the personal identity and the sense of belonging are formed (FISCHLER, 1988). From the Latin *habitus*, habit means constant willingness to act in a certain way (FREITAS et al., 2008). Thus, eating habits represent a contextualized attitude that is regularly and unconsciously repeated and results in an acquired disposition associated with psychological and social meanings, which are difficult to modify after acquisition. (ROZIN et al., 1999; AL-SAKKAF, 2013). Conversely, food preferences have been transformed into habits and traditions over the centuries, and time is needed to modify them (CASCUDO, 1967; GALINDO and PORTILHO, 2016).

With industrial developments and the consequent urbanization processes, society has become less dependent on the harvest cycle (MONTANARI, 2004). The

concentration in urban centers changed the food trade and people's relationships over the time (CONTRERAS and GRACIA, 2005; MONTANARI, 2004). Today, products are sold at supermarkets (SILVA et al., 2018; POULAIN, 2017; FISCHLER, 2013) and their prices carry intrinsic value quantified in money. The barter and exchange systems no longer exist. Food is now stored in refrigerators (SILVA et al., 2018), and not preserved in animal fat, salt, or vinegar (MONTANARI, 2004). Time is no longer measured by the sun's movement, and food access is no longer directly dependent on the growth of plants and animals (CONTRERAS and GRACIA, 2005). Clocks have become essential (HARARI, 2015). With stipulated times to start and stop, the workforce is now rewarded with money instead of actual goods for sustenance. The week has been divided into workdays and days off (HARARI, 2015). Women, the traditional keepers of food knowledge and responsibilities for cooking, joined the labor market (POULAIN, 2017; FISCHLER, 2013). Communities and families were replaced by the state and markets and religiosity by secularism (HARARI, 2015).

The evolution of civilization has also changed cuisine habits (POULAIN, 2017). The floor fire and simple stove have been transformed into gas or electric appliances, which takes less time to cook (PUPPO, 2017). To protect food and reduce waste nowadays, food is sold inside packaging and frozen in freezers (SILVA et al., 2018), rather than displayed in blocks of snow, fat, or brine (KNORR and WATZKE, 2019). Products and regional ingredients have crossed over the geographic barriers (FLANDRIN and MONTANARI, 2013). With globalization, some cuisine traditions disappeared while others expanded, created, or “fused” in modern terms. For example, potatoes were included in Irish cuisine, tomatoes in North-American, corn and cassava in Africa and Europe, wheat flour in Brazil (CONTRERAS and GRACIA, 2005), and Mexican pepper in India (HARARI, 2015).

Rising from different geographic cultures, foods have hardly kept their original characteristics (MONTANARI, 2004). For example, a sweet drink produced in Switzerland by a local company, if marketed in France, will have the sweetness reduced. In the same way, if the target audience of this company is Italian, Portuguese, or Brazilian, the sugar content probably will be higher than the original one (MONTANARI, 2004). These cultural adaptations can also be exemplified by the coffee that, even from the same brand, has a different flavor in Italy, Denmark, and USA (POULAIN, 2017). No matter the processing place (industry, home, or franchise restaurants), food will undergo

modifications based on the contemporary food habits of where it is eaten. In France, McDonald's franchises offer beer as a drink option; in the USA and Brazil, only non-alcoholic beverages or soft drinks are options. In France, Netherlands, and Belgium, fries are accompanied by mayonnaise, while in the USA it is ketchup, but in Brazil it is both mayonnaise and ketchup, whereas in Quebec (Canada), a sauce and cheese, similar to poutine (POULAIN, 2017) is popular.

Poulain (2017), as well as Fischler (1988) and Montanari (2004), considered that globalization and the market's internationalization will result in culinary compositions and re-compositions; therefore, globalization is not restricted in being a destructive source of regional food and culture. Industrialized food has no symbolic, moral, or ideological value as traditions. Nonetheless, even inside the same culture it is possible to have differences, such as the definitions of the food, the way it is processed, the rules for eating, and even the attached moral values. Thus, besides it being on the stage with symbolic and ideological conflicts, food also identifies boundaries in distinct cultures (POULAIN, 2017). In this way, culinary traditions cannot be simplified to ingredients or recipes fixed to some place or time (MACIEL, 2004; CANESQUI and GARCIA, 2005).

To Contreras and Ribas (2012), our omnivore deculturization will happen due to food's medicalization, and not only because of food industrialization. The belief that health can be attained just by food choices will transform food into healthy molecules that prevent illness. It is well known that the low consumption of nutritious foods can cause diseases; thus, food can be considered as a source of health.

1.5. Physiology, hedonism, fearfulness, and blame

The primary function of food is to supply energy and nutrients for the maintenance of life. The human being eats to live (GALINDO and PORTILHO, 2016). By definition, diet is the individual's dietary pattern (VAZ VELHO et al., 2016). It is a source of health, taste and pleasure and is influenced by culture, geographical localization, religion, and lifestyle (VAZ VELHO et al, 2016). On the other hand, when inadequate, diet can be also a source of illness (AMORIM et al., 2022; FISCHLER, 1990). Despite increases in food production, people are still hungry, malnourished, and overweight (AMORIM et al., 2022; SILVA, 2020; LAZARIDES, 2012; LUCAS and HORTON, 2019; WILLETT et al, 2019). Malnourishment and obesity are reflexes of inefficient or wrong food intake,

unbalanced by nutritional and caloric points (AMORIM et al., 2022; GALINDO, 2014; LAZARIDES, 2012). Access to nourishing food is essential to providing the physiological needs of humans and maintaining life; however, the lack of education about food hampers good health (LAZARIDES, 2012; AMORIM et al., 2022). In this way, fake news and misinformation can create insecurities and uncertainties related to food intake and may induce anxiety and even cause panic situations (POULAIN, 2017).

Homo sapiens have not yet completely learned to control their brains, their desires nor their reactions (HARARI, 2019). When neurons are activated and synapses fire unconsciously, they produce biochemical processes that have been influenced by cultural factors. Desires are not planned; we just feel them. In this context, the external and virtual world - many times unreal - can cause significant damage, such as an obsessive search for opinions, feelings, and desires, which are manifested in the need for social belonging (HARARI, 2017, 2019). The relation between hunger-satiety is also influenced by hedonism (CONTRERAS and GRACIA, 2005), and the exaggerated concern with diets can cause psychological unbalance, a decreased quality of life, and lower life expectancy (ROZIN et al., 1999). In other words, by provoking anxiety in the eater, exacerbated concerns about diet can harm health rather than improve it. For example, North Americans are generally more concerned about diet than the French (especially about health and appearance); however, the French have a healthier diet than North Americans (ROZIN and HOLTERMANN, 2021; ROZIN et al., 2019; ROZIN et al., 1999; FISCHLER, 1990). On the other hand, in a recent cross-cultural study, Sproesser et al. (2022) analyze 10 countries (Brazil, China, France, Germany, Ghana, India, Japan, Mexico, Turkey, and the USA) with regard to traditional and modern eating, and in contrast to past studies (ROZIN et al., 1999, 2003, 2011), attitudes to food or potion sizes when it comes to what constitutes traditional and modern eating, USA and France, now appears similar. Additionally, Sproesser et al. (2022) also describe that in countries with huge extension (such as Brazil and USA) probably there might be heterogeneity not only in terms of different regions but also with regard to different ethnic groups within one country.

Guiding food choices, as presented in the Food-Based Dietary Guidelines (AMORIM et al., 2022) by food classification strategies and considerations of food-intake behavior, is extremely complex (ESPEITX et al., 2013). In addition to accessibility, availability, taste, nutrition, or the consumption situation (such as festive or

daily one), there are also emotional, cognitive, psychosocial, and cultural issues (FISCHLER, 1988, 1990; CONTRERAS and GRACIA, 2012). Food choices are specific to the context. The social environment is an essential delimiter of likes and choices (ROZIN, 1988). Social life is modulated by feelings and definitions of what is allowed/prohibited and even from what is impure (GALINDO and PORTILHO, 2016; FISCHLER, 1990). Impurity is related to blame, gluttony, disgust, and laziness. Gluttony is associated with pleasure in eating. Laziness is a certain discouragement to daily cooking, which can be understood as an aversion to work. Blame and disgust are about whether or not the food is good to eat, but in a cultural judgment, there is no relation with health (GALINDO and PORTILHO, 2016; FREITAS et al., 2008). Food is frequently consumed in moral terms due to what the cultural conceptualization regards as good and bad (acceptable/not acceptable), not necessarily or exclusively, taking into account particular likes of individuals such as the taste of the food or even the desire to eat it (MONTANARI, 2004). In this way, a food transgression can imply moral judgment and blame in the eater (FISCHLER, 1990). Blame is also linked to the food ingredients, which can be understood as dangerous to eaters (GALINDO and PORTILHO, 2016).

These feelings cause conflicts to the eater that can harm their physical and mental health. In the contemporary world, hedonism has been assumed an emotional rather than a sensory character (BARBOSA and CAMPBELL, 2006). Most healthy foods are not tasty. In this context, the desire for healthy-eating opposes hedonism. Fresh food is seen as pure, while industrialized food is viewed as artificial (CÁCERES and ESPEITX, 2019; CONTRERAS and VERTHEIN, 2019; ROZIN, 2005, 2006; ROZIN et al., 2012; VERNEAU et al., 2014). Recently, psychologists defined "*orthorexia nervosa*" as the obsession to eat healthy (McCOMB and MILLS, 2019; DOUMA et al., 2021). According to Bhattacharya et al. (2022), *orthorexia nervosa* describes a fixation on food purity involving ritualized eating patterns and a rigid avoidance of unhealthy foods. Unlike anorexia and bulimia nervosa, orthorexia is related to food quality (in a healthy sense) and not quantity or corporal mass (DOUMA et al., 2021). Watchful to the market, some brands are offering food products that meet these customer's needs (GALINDO and PORTILHO, 2016), including rescuing the idea of nostalgia and tradition (GASPAR et al., 2019). Nonetheless, cultural and emotional rescue involves the use of terminologies and definitions that are not yet clearly defined, such as artisanal, traditional, and natural food, which are being specially labeled by food producers (companies or entrepreneurial

enterprises) and which can carry can mistakes and misinformation that consequently engender more insecurity, distrust, and anxiety in the eater. Because of this, transparency is fundamental for food industries (SILVA et al., 2018).

1.6. Food Industry, traditional recipe, and fast food

Full of ancestry, many cuisines have been changing over centuries. Even in places famous for their traditional heritage, it is hard to find meals with the same taste that were made by past generations. Tradition is mutable; however, the meals carry worldviews (SOUZA JUNIOR, 2011). If one recipe dies, it will take its vision (MONTANARI, 2004; SOUZA JUNIOR, 2011). In the modern and globalized world, food preference is divided between the traditional (cultural heritage) and the modern (international, innovative, and practical) (DÓRIA, 2014; GUINÉ et al., 2021). Products never seen or tried by some cultures have started to appear on supermarket's shelves, restaurants, food events, and over the years, frequently inside homes (POULAIN, 2017; FISCHLER, 1990). Avocado, guacamole, kiwi fruit, tabbouleh, paella, tacos, pizzas, pineapple, soy source, raw fish, among others regional culture dishes, are present worldwide nowadays in many cultures (FISCHLER, 1990).

Montanari (2004) describes how *Homo sapiens* used agriculture to build food-induced post-industrial cultures into a mistaken conclusion that there is fundamental naturality in agrarian activities, usually considered as tradition. There is no definition of natural products (ROZIN, 2005, 2006; ROZIN et al., 2012). For example, flour obtained from wheat - present naturally in nature - gives rise to bread that, in turn, does not exist naturally in nature and yet is considered a traditional food in several countries of the world. The same can be considered with the cheeses, wines, and beers of French, Italians, and Germans, respectively. In addition, there is also a mistaken understanding that "more natural" foods are safer (SILVA, 2020). This kind of thinking ignores that toxins and pathogens extremely dangerous to life can be naturally present in fresh foods. To Montanari (2004), the differentiation between what is naturally in nature and what is obtained from it distinguished human and animal identities and, from the social point of view, originated civilization.

Fischler (1990, 2013) reviewed some historical changes in cuisine. In the last century, circa the 1930's, a considerable amount of collective culinary activity was

redirected from the kitchen to industry (FISCHLER, 2013). In the past, cuisine knowledge was transmitted essentially from mother to daughter (FISCHLER, 1990). With the functional social changes of urbanization and the advance of industrialization processes, many women entered the workforce. The role of cooking and the-perpetuation of cooking knowledge were no longer exclusive to women to teach and learn. Recently, although in lesser numbers, men also have been working in the kitchen (AMORIM et al., 2022; FISCHLER, 1990, 2013). Nowadays, food knowledge (traditional or not) can also be obtained individually, by books, videos or from social relationships that do not necessarily involve family or other feminine authority (FISCHLER, 1990).

This reality especially challenges the traditional cuisine producers that, depending on the customer acceptance, have to make minor changes in the recipes to improve health, safety and convenience (GUERRERO et al., 2022) without losing the tradition and taste. Currently, health issues can overlap the traditional issues (GUINÉ et al., 2021). Souza Junior (2011) relates that in the Candomblé religion, where tradition is valued, it is possible to note the incorporation of industrial ingredients and the rejection of the traditional ones to avoid illness. Although understood as healthier by the lay population, there is no correlation between healthiness, traditional food (GUINÉ et al., 2021), and industrialized food (TALENS et al., 2020). The Mediterranean diet is considered healthy by the scientific community (TIERNEY and ZABETAKIS, 2018); however, traditional products consumed by these peoples, such as hams, olives, pastries, and cheeses, can have high contents of salt and/or fats (HIDALGO-MORA et al., 2020), as a percentage of energy, total fat content can be as high as 40% with over half being monounsaturated fat (TIERNEY and ZABETAKIS, 2018). Even so, some of them have been classified as ultra-processed foods, which means unhealthy in some Food-Based Dietary Guideline (FBDG), such as Brazil's, which uses the NOVA classification (MINISTRY OF HEALTH OF BRAZIL, 2015). The Mediterranean diet is healthy because of its nutritional biodiversity and moderate consumption, complemented by philosophy of life that values personal relationships, the pursuit of happiness and physical activity (GUINÉ et al., 2021; MAGGI et al., 2021), and not necessarily in the function of the quantity of unit operations that food has been submitted. The Mediterranean diet pyramid has socio-cultural relationships and physical activities on its base, i.e., as a priority even before food choices (MAGGI et al., 2021). The Brazilian FBDG, despite using NOVA classification, also orientates people to experience social and pleasurable eating time.

Traditional food is made with regular ingredients, following the usual processes of traditional recipes. The tradition involves knowledge, techniques, transmitted values (MONTANARI, 2004), and emotional and ancestral issues (GUINÉ et al., 2021). There is no official definition of traditional food. Guerrero et al. (2022) explained that traditional food can be "a product frequently consumed or associated with specific celebrations and/or seasons. It is normally transmitted from one generation to another, made accurately in a specific way according to the gastronomic heritage, with little or no processing/manipulation, distinguished, and known because of its sensory properties and associated with a certain local area, region, or country". According to the European Commission "traditional means proven usage in the community market for a period showing transmission between generations; this period should be the one generally ascribed as one human generation, at least 25 years". Readers interested in studying the definitions of traditional food are invited to consult Guerrero et al. (2022).

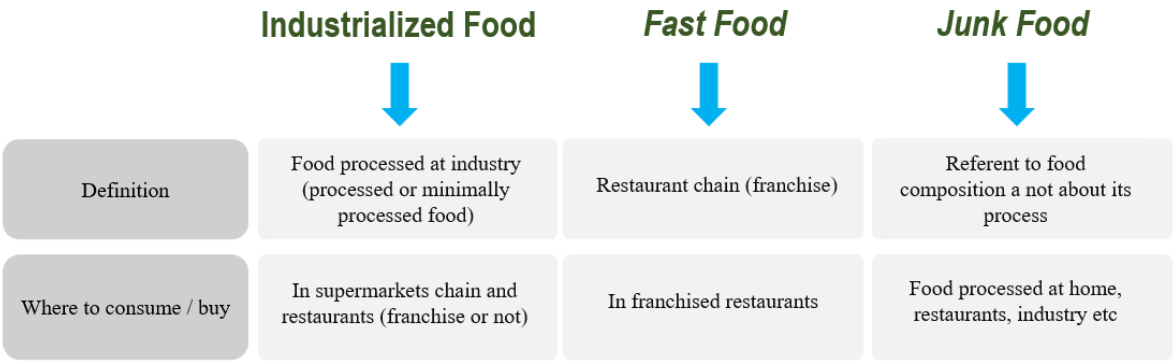
Tradition is part of the food's cultural heritage (LANNI, 2020); however, culture is related to tradition and innovation (MONTANARI, 2004). Nonetheless, in the contemporary world - practical, international and industrialized - is it possible to have the same food as our ancestors, even by a traditional recipe? Ingredients are everything that is incorporated into a recipe (DÓRIA, 2014). Nowadays, to guarantee food safety, the ingredients have been industrialized. Regardless of the safety issues, could modern ingredients modify a traditional dish? Reconstructing the original recipe is highly ambitious (MONTANARI, 2004). Despite the ingredients, could modernity, viable by domestic utensils (stove, steel or aluminum pans etc.), modify traditional dishes? Cooking is a skill of combinations (MONTANARI, 2004) that, over the years, can proportionate new dishes or newly adapted versions of dishes (POULAIN, 2017; FISCHLER, 1988; MONTANARI, 2004). As with culture, human taste is not static (MONTANARI, 2004); therefore, the perception of different flavors of traditional dishes can be due to the modification of ingredients, preparation method and taste. In addition, according to Montanari (2004), the human organ responsible for the perception of taste is the brain, and not the tongue, and the brain's perception, in turn, is strongly influenced by our culture.

Another diet consequence of the modern lifestyle involves time. Stimulated by the accelerated routine and often full of anxiety, people choose food that does not require more time and stress in their decision-making. In this context, fast-food chains have

increased worldwide as business model franchises, such as McDonald's, Subway, Starbucks, KFC, Taco Bell, Domino's, Pizza Hut, Dunkin Donuts, Papa John's, Burger King etc. Fast food offers convenience with little tradition (FISCHLER, 1990, 2013), and other similar franchise-type restaurants now dominate food plazas of modern malls or shopping centers worldwide. This eating style induces people to have meals unconsciously, occasionally alone, to supply their physiological need (hunger). Fast food can trigger "disenchantment with the world" and is defined by sociologists as loss of meaning and devaluation of emotion (DÓRIA, 2014). In addition, the worldwide spread of this North American culture, especially in European countries, has provoked some anxiety and fear of losing national or local identity (FISCHLER, 2013; LANNI, 2020). Generally, fast food is eaten with the fingers and without a plate or cutlery, in contraposition to other styles like the French eating etiquette or Asian traditions where a much different set of dining manners are civilized standards. This difference in the manners of eating, independent of what kind of food, can cause a conflict of feelings and moral judgments in the eater (POULAIN, 2013). Despite being associated with hamburgers and junk foods, this restaurant style provides different kinds of food, such as pizza, national food (Japanese, Korean, Mexican, Arabic, Brazilian etc), and also traditional homemade like food.

In the context of health, more than 1/3 of the worldwide dietary guidelines advise to avoid fast foods (HERFORTH et al., 2019), but herein lies common conceptual mistakes that lump together fast food, industrialized food and junk food. Industrialized food is processed by a company with industrial equipment at an industrial level. Industrial food is available to the eater/customer by the retail segment and restaurants as well. Fast food is not necessarily industrialized food, although they can use industrialized products for cooking and an industrial philosophy to operate (similar to Fordism) (FISCHLER, 1990). Further, junk food has come to signify low nutritional quality foods (SADLER et al., 2021; YEN, 1982), which may include food processed at industry, home, or restaurants (franchise or not). In a more accurate summary: Junk food depends on the nutritional composition of food; fast food is the restaurant's style, and industrialized food is food that is mass processed by industry (Figure 2).

Figure 2. Fast food, junk food, and industrialized food – definition and differences.



Source: The authors.

For people who regard traditional foods and moral values as important, industrialized food and fast food are transgressions (POULAIN, 2017). Nevertheless, one food can be beneficial where another is not, depending on the context. Diet food is healthier for people who suffer with diabetes, but not necessarily to all the population. Regular yogurt can be good for people who do not suffer from lactose intolerance. Fish is good for people who appreciate its taste. Therefore, when food is involved, there is no universal rule. In this way, generalizations are equivalent to misinformation. Sanitary rules - such as the use of pasteurized milk to process all kinds of cheese and derivatives in some countries and a public health policy to avoid foodborne disease - affect the moral and cultural value of food. Cultural heritage and food safety are important to society and contribute to the economy (GUERRERO et al., 2022). Public health agencies and scholars must find a way to conciliate it. In this context, the Food-Based Dietary Guidelines (FBDG) can be a powerful tool to guide food choices, exploring the country's food and culture diversity, including regionalities, beliefs, and philosophies of life, lifestyles, age group, different identities inside some culture (such as indigenous people), different conditions of life (such as breastfeeding, intolerants and allergic, etc.) among others. This, however, requires more multi and trans disciplinary work.

1.7. Should I eat it?

To Fischler (1988, 1990) and Contreras (2005), the omnivore experienced dilemmas that the cow or koala never had. *Homo sapiens* have a vast variety of foods, taboos, rules, traditions, and beliefs, resulting in conflicting emotions, mainly about the

unknown. Neophobia and neophilia are conflicts experienced by humans when faced with an unknown food (VERNEAU et al., 2014). Neophobia is the fear and rejection of the new, while neophilia is the fear and curiosity about the unknown (CIFCI et al., 2020; FISCHLER, 1988, 1990; CONTRERAS and GRACIA, 2005; VERNEAU et al., 2014; SINGH, 2019). In contrast with domestically processed foods, industrialized food causes more rejection and unsafe feelings in eaters (CIFCI et al., 2020).

When faced with industrialized food, the eater/customer does not know the origin, the quality, and the history of the food (FISCHLER, 1988, 1990; CONTRERAS and RIBAS, 2012). Therefore, food processed at home and a part of the country's culture produces less neophobia and brings tranquility and mainly familiarity to the eater (VERNEAU et al., 2014; GALINDO, 2014; CIFCI et al., 2020). Industry must inform and be clear about the new product's ingredients and consider-their risks and benefits to reduce neophobia and improve eater/customer acceptability (CIFCI et al., 2020). With the development of the food industry, from the historical point of view, food security, food safety, and poisonings were controlled and strongly reduced (CONTRERAS and GRACIA, 2005). Scientific knowledge about microorganisms, pathogens, and toxins has never been as precise or complete as today. However, despite safety improvements, there is a mistaken perception of risk by the eater/consumer (GASPAR et al., 2019; AGUILERA, 2006; CONTRERAS and GRACIA, 2005). Although food safety is one of the FSTE professionals' pillars; nonetheless, this concern is not noticed by the consumer.

The insecure feeling proportionated by the lack of this knowledge induces people to look for a food that they believe to be safer and healthier (GALINDO and PORTILHO; 2016) as well as to idealize the past (GASPAR et al., 2019). Consequently, many entrepreneurs - and even big companies – have emerged selling artisanal or gourmet products that attempt to keep and rescue the traditions and origins (CANESQUI and GARCIA, 2005). Yet, fresh products (fruits, vegetables, and animals - dairy and meat) can be a source of contaminants and diseases (GALLO et al., 2020; ORTEGA-RIVAS, 2010). To ensure food safety in the industry, technical knowledge and good practices (such as efficient hazard analysis and critical control points - HACCP) and health regulations are primarily used (AWORH, 2020; GALLO et al., 2020). Consumption of food, which has been erroneously deliberated for production, can ignite illnesses already controlled that are caused by viruses, bacteria, fungi, and toxins (GALLO et al., 2020). In this context, especially for fresh food, minimally processed food (MPF), non-thermal

processes and special active packaging have become effective optional methods to offer safe and fresh products (BARBOSA-CÁNOVAS et al., 2002)

Some literature states that the concept of risk changes according to the culture and history of the population (GASPAR et al., 2020; GIORDANO et al., 2018). Usually for French and Spanish women, pesticides, medicines, microbial contaminations, pollutants, genetically modified organisms (GMO), and epidemics represent a health risk, but these concerns for Brazilian's women are dependent on their social class (GASPAR et al., 2020). Industrialized food and chemical components (including food additives) also cause mistrust (CONTRERAS and GRACIA, 2005). The chemical products used by the food industry are regulated and monitored by oversight agencies of each country. For many people, however, the government sometimes seems to protect companies (agribusiness, industry, and supply chain) more than the eater/customers (CONTRERAS and GRACIA, 2005; GALINDO, 2014). Disoriented, the consumers then only access media information, which can sometimes exacerbate fears and phobias (GALINDO and PORTILHO, 2016; CANESQUI and GARCIA, 2005). Nowadays, fake news and many possible problems are exaggerated by social media interventions (AMORIM et al., 2022).

By definition, "a risk" is a possible future adverse effect resulting from human choices and actions. (AL-SAKKAF, 2013; GALINDO and PORTILHO, 2016). Nonetheless, sometimes, the risk is not associated with health. For some, the risk of getting fat is related to belonging to an aesthetic standard and not only to avoid diabetes or obesity (CONTRERAS and GRACIA, 2005; FISCHLER, 1990). However, exaggerated concerns with diet, aesthetics, and fads can trigger diseases such as anorexia, bulimia (LAZARIDES, 2012; FISCHLER, 1990), and orthorexia nervosa (McCOMB and MILLS, 2019; DOUMA et al., 2021). Within the same culture, the understanding of risk can vary according to gender, social position, values, and beliefs (GALINDO, 2014; GIORDANO et al., 2018). Regardless of the concept, the eater/customer better accepted old or already known risks (VERNEAU et al., 2014). Frozen foods were not well accepted by the population at the beginning of the 1940's, when the freezers started to be useful in society. Now they are commonplace (CONTRERAS and GRACIA, 2005).

The consumption decision is according to the balance between the risk perception and the perception of the product's potential benefits (GIORDANO et al., 2018). The eater/customer feels insecure because they feel and are no longer willing to trust. Despair, skepticism, and doubt surround the eater during the decision-making

(GALINDO and PORTILHO, 2016). Purchase decisions are driven by three motivations: sensory attractiveness, biophysiological and social benefits (prestige and nutrition), and ethics (origin and ideological issues) (ROZIN, 1988). Barbosa and Campbell (2006) describe that consumption and identity are linked; however, the identity is more connected to the consumer's reactions to a product (feelings and desires rather than necessity) than to the product itself. To Galindo and Portilho (2016), it is inaccurate to relate purchase and trust. The purchase represents daily experimentations, permeated or not, by luck. This mistrust results in fear, which can be fed by facts or fake news (GALINDO and PORTILHO, 2016). When a person is scared, rational human capacity is limited (CONTRERAS and GRACIA, 2005).

Consumer goods are a visible part of the culture (PORTILHO, 2009; BARBOSA and CAMPBELL, 2006). Portilho (2009) explains that consumption choices are related to belonging experiences that, in some cases, classify the decision made as superior or correct. In this way, consumption and culture are linked to cultural and moral aspects (BARBOSA et al., 2014). Moreover, consumption is also associated with moral feelings such as “good citizens” or “good parents” and “good family” (PORTILHO et al., 2011). Industry and the kitchen have the same primary function of processing and preserving foods; however, to some people food processed at home is like the “good mother”, purified by the love and familiar ritual, while industrialized food is like the “bad mother” and, therefore, a product of untrustworthy manipulations (FISCHLER, 1990).

Moreover, the act of following collective thinking, especially when influenced by concepts of equality, citizenship, and freedom of thought, are the way to achieve “good, fair and happy life” (BARBOSA et al., 2014). In this way, the understanding of food as nature leads to its idealization, which contrasts with the way most people consider some technologies and even cultural practices. This influence is a new conceptualization of what is good, healthy, and faithful (PORTILHO et al., 2011). Food is the convergence point of state, corporations, and individuals (PORTILHO et al., 2011). Distrust of public institutions increases the politicization of consumption (CANCLINI, 1995), in which the individual perceives their consumption as a form of participation in the public sphere to boycot or “buycot” products and brands (BARBOSA et al., 2014; PORTILHO et al., 2011). Currently, the customer has migrated into more critical, autonomous, and active behaviors (PORTILHO et al., 2011; BARBOSA et al., 2014). Modern consumers assign responsibilities and duties to themselves in the social and environmental context

(PORTILHO, 2009; BARBOSA et al., 2014). Consequently, during 2010-2017 around 30,000 products introduced ethical, social, and environmental practices on their labeling (SILVA, 2020).

Despite FSTE concerns about food safety, the feeling of security does not necessarily convince the customer. Although scientific knowledge has never been as voluminous as it is today (CONTRERAS and GRACIA, 2005), the concept of risk has never been so mistaken (GASPAR et al., 2019). The lack of knowledge about the origin, the process, and the food in general, including the controversial information advertised in the arenas of foods and the traditional and social media, fuels mistrust and moral conflicts. For the eater/customer, the right to access quality food includes the right to make free and well-informed choices, according to each individual's preference (LANNI, 2020); therefore, transparency among institutions, eaters/consumers, and corporations becomes a vital factor in contemporary feeding (PORTILHO et al., 2011).

1.8. "Canned", "ultra-processed," and "functional" food. What do customers understand by industrialized food?

There is no life without food. Regardless of how food is understood, every person in the world eats and has at least a minimum knowledge about food (MONTANARI, 2004). Before the Industrial Revolution, laypeople cultivated food without technical regulation and agency monitoring. In 1850, 90% of the population were landsmen (HARARI, 2017), nowadays it is less than 40% (WORLDBANK, 2021). In previous eras, food poisoning and hunger were recurrent and responsible for many deaths, especially in Europe (SCHNEIDER, 1979) and Russia (SATIN, 2014), and were neglected in other countries. Foodborne disease and hunger began to be controlled with the development of the food industry when the thermal process was developed and applied by industry (BARBOSA-CÁNOVAS et al., 2002; FEATHERSTONE, 2012; SILVA et al., 2018; JONES, 2018; VERGARA-BALDERAS, 2016; SATIN, 2014). During wars, the first people to experience neophobia/neophilia with industrialized food (commercially sterilized food in glass or tin packaging) were soldiers and expeditionary troops (SATIN, 2014).

Processing turns agricultural commodities into edible, safe, healthy, and nourishing products (CHUNG et al., 2022). Processing food in current industry

guarantees a standardized, transportable and safe product to consume for a longer period (KNORR and WATZKE, 2019; PETRUS et al., 2021; BOTELHO et al., 2018; ORTEGA-RIVAS, 2010; BARBOSA-CÁNOVAS et al., 2002). However, food acceptance of industrial and later frozen food was slow and surrounded by mistrust. To Cascudo (1967), "the food industry reduces the kitchen to a cabinet with cans, where the essential technique is to open the can without hurting the fingers." For Giralmo Sineri, "Canning is anxiety in its absolute state" (MONTANARI, 2004). In addition, widespread speculations without evidence about botulism and chemical contaminants added to food at packaging had intimidated the population to consume it (SATIN, 2014). Moreover, despite some canned food being nourishing, the perceived health loss during the thermal treatment raised neophobia (FEATHERSTONE, 2012; SCHNEIDER, 1979). Currently, commercially sterilized food is widely presented in the market (TEIXEIRA, 2011); however, now it is not only canned, but also in polymer-based pouches, cardboard-based packages, and glass bottles, as well (FEATHERSTONE, 2012). To be accepted, new foods must be part of the population's habits, have good quality, an affordable price (SCHNEIDER, 1979), and a short cooking time. It takes a long time to achieve consumer/eater trust and break down the neophilia barrier (CONTRERAS and GRACIA, 2005).

With the rise of the food industry and despite the diversity of products and packaging, all industrialized food was labeled as "canned" food. Nowadays, terms such as "processed" or "ultra-processed" food are used to mean industrialized food, both with a pejorative meaning (KNORR and WATZKE; 2019; ARES et al., 2016). However, food processed by industry is nothing more than an adaptation on a large scale of home processed food, and it is made with scientific knowledge and rigorous control (AGUILERA, 2018; KNORR and AUGUSTIN, 2021). Meals made at home or restaurants are also processed, but not always with technical control. Fortunately, they are usually consumed just after cooking, which means their shelf-life is not a concern.

The Brazilian and the Uruguayan Food-Based Dietary Guidelines (FBDG), adopted by governors as a public policy tool, classified food by their processing level to indicate nourishment (AMORIM et al., 2022). The term "ultra-processed" (UP) food (created by NOVA classification), means "not real" food (MONTEIRO et al., 2019) and, despite being classified by processing level, the arguments used for avoiding this food are their ingredients and not their process parameters (AMORIM et al., 2022; KNORR and

WATZKE, 2019; BOTELHO et al., 2018; JONES, 2018; CARRETERO et al., 2020). Despite the good intention behind this classification system, and most notably, there is no relation between healthiness and processing levels (TALENS et al., 2020; GIBNEY, 2018). Among those foods classified as UP food, nourishing foods are included (DERBYSHIRE, 2019; GALAN et al., 2021). Moreover, diets without UP food can also be unhealthy (SADLER et al., 2021), and there is still confusion about junk food definitions.

Furthermore, the term UP does not exist in Process Engineering terminologies. To the FSTE, a process is a sequence of unit operations (AMORIM et al., 2022), and "ultra" means high intensity - such as ultra-high temperature, ultra-filtration, filling ultra-clean, and ultra-efficient, etc. - and not quantity. The NOVA classification was created by health professionals, who are experts in health segments, such as epidemiology, and recognized inside the scientific field; however, they lack expertise in food processing (e.g., unit operations and process engineering). The terms UP and "real food" are misleading (KNORR and WATZKE, 2019; DERBYSHIRE, 2019) and do not help to improve the understanding of healthy food (AMORIM et al., 2022). Although the concept of UP foods has certainly entered the consumer consciousness, some mistakes have been made to unequivocally and accurately classify them, as observed by Braesco et al. (2022).

Still, despite being an industrialized food, functional food has good customer acceptance and is a market trend (BIGLIARDI and GALATI, 2013). With a healthy role, functional food provides additional nutritional benefits (GIORDANO et al., 2018; SINGH, 2019). Dominated by probiotic products and functional ingredients that have been developed in all food categories since the 1980's, such as dairy, soft drinks, baked goods, baby-food markets, etc. (BIGLIARDI and GALATI, 2013). People have accepted that functional food consumption improves health. Thus, despite the fact that food decision-making is intrinsically related to the historical, social, and cultural context of each country, the association of food and health has disseminated worldwide (GASPAR et al., 2020).

In the modern world, people are concerned about health and longevity. At the same time, convenience is a need, and the Food Industry is essential to accomplish it (SILVA, 2020). Yet, after about 200 years of the food industry's existence and 60 years after Food Engineering became an established field of science, this has not been enough for some people to trust and feel safe with industrialized food. It is a consensus that, if

safe from the microbiology and toxicologic point of view, fresh food or minimally processed food should be the main source of nutritious food, but for people who do not can foods or do not want to cook, a quality alternative must exist (GALAN et al., 2021). Furthermore, people lack knowledge about industrialized food, quality, and food safety in general (SILVA, 2020), so how can they trust in something they do not know sufficiently? The inclusion of food subjects in basic education, such as food education, food safety, nourishment, good domestic food handling, and sustainability issues, must be considered in a public policy tool (FARIAS et al., 2020).

1.9. Further Considerations

Some life philosophies aligned to faith understand food as a source of life or contamination. From the religious point of view, food - especially the ones related to rituals - can have spiritual meaning in addition to its nutritional value. For example, Easter eggs represent a new life and resurrection in Christ in Catholicism. The bitter herbs and bread used by Jews on Passover symbolize their periods of slavery and escape from Egypt. Moreover, in their New Year celebration and in a wish for the new year to be sweet, Jews eat honey to be fertile; eat fish to always move on and ahead, and they eat pomegranate seeds so that their good actions are multiplied (HARARI, 2019). In the yam (or pestle) celebration of the Egibô kingdom in Nigeria, the cake preparation and consumption represent their survival and splendor, and it signifies means life and death, hunger and abundance, disease and health (Candomblé, an Afro-Brazilian religion). The elements of this ritual are synonymous with strength (SOUZA JUNIOR, 2011). Furthermore, to Muslim's food can influence the soul, behavior, and moral and physical health; thus, food consumed by them must be Halal, i.e., according to the law of Islam (KOHILAVANI et al., 2021). According to Fambras (2021) and Jia and Chaozhi (2021), Halal products increase between 15-20% a year worldwide, and it is estimated that the Islam population will represent around 30% of the world population in 2050.

According to Junior Souza (2011), to Afro-Brazilian religions, especially to Candomblé, food is a synonym of "axé", which means life. To Candomblé, nothing can remain without food, and their correct consumption is related to health maintenance. Food is the source of axé and transmits vitality and heat. When the heat is over, the body dies. In addition, the rituals involved in the food preparation also are important and, if it is performed in an inappropriate way, it could provoke the opposite effect (SOUZA

JUNIOR, 2011). Similarly, in a deep way, food is mystic for Catholicism and represents God. It is God in the mouth. Throughout the ritual, bread and wine become the body and blood of Christ (HARARI, 2019; CANESQUI and GARCIA, 2005; POULAIN, 2017).

Besides religions, food is also the center of some philosophies of life, such as vegetarianism and its derivations (veganism, flexitarianism, and others) (CRAMER et al., 2017; ROSENFELD, 2018; CORRIN and PAPADOPOULOS, 2017; RUBY, 2012). These derivations are a consequence of a vast eating lifestyle which either does not include or restricts the consumption of animal food (meat, eggs, milk, cheese and so on) (CRAMER et al., 2017). This action is motivated by ethical issues about animal well-being, the environment, and health (ROSENFELD, 2018; CRAMER et al., 2017; RUBY, 2012; POLLAN, 2007). Vegetarianism and its derivations are related to identity issues and the individual's personality (ROSENFELD, 2018). It is a food intake and lifestyle choice practiced by adults (RUBY, 2012). People become vegetarian during adolescence or adulthood. Adhering to this philosophy is a conscious decision, not an imposition (ROSENFELD, 2018).

Although vegetarianism philosophy is old, scientific studies about its social, ecological, and health consequences are quite recent and need further deepening (ROSENFELD, 2018; CORRIN and PAPADOPOULOS, 2017; CRAMER et al., 2017; RUBY, 2012). Some supporters of this philosophy report losing weight with a diet without meat. Others consider that this diet can improve health and avoid diseases such as diabetes and hypertension. Furthermore, in comparison to omnivores, vegetarians usually are more concerned about health issues (CORRIN and PAPADOPOULOS, 2017; ROSENFELD, 2018). No scientific evidence, however, exists to classify vegetarianism as healthier or unhealthier feeding systems (CORRIN and PAPADOPOULOS, 2017). The only scientific evidence is about the vitamin B12, zinc and iron absences (CRAMER et al., 2017).

Philosophies of life are connected to sociocultural issues and identity groups (ROSENFELD, 2018). In a multicultural society, all the (food) lifestyles have to be accepted and have space in society. In addition, the ideological movements related to food, besides being an arena of ethical, ecological, and public health discussion, can represent an essential role in the economy. This is a new market to be served generating new business and creating an improved economy. Time to cook and difficulty to find a

convenient vegetarian food or vegetarian restaurant are the main barriers described by vegetarians (CORRIN and PAPADOPOULOS, 2017).

As new business opportunities open, the food market tries to adapt to new demands, both in terms of operating procedures and in the development of new products. FSTE professionals are looking to develop products similar to meat with no animal sourcing. In addition, technologies such as nutritional enriching by nano or microencapsulation have been studied and applied in new products to mitigate possible nutrition losses (BHAT et al., 2019). The FSTE professionals understand that healthy and sustainable food intake is a universal right regardless of religion and philosophy of life.

1.10. Concluding Remarks

Food Science, Technology, and Engineering aim to supply quality food to every single person worldwide. Quality is synonymous with safety, nourishment and taste to the professionals in these domains; however, in addition to technical and food safety knowledge, understanding social anthropology is crucial to develop and supply food quality. Eating is a complex and multifactorial issue. A multidisciplinary task is required to have success in reaching this goal. Recently, new issues about healthiness have emerged in society. Food-Based Dietary Guidelines were made worldwide to improve health and quality of life by food-intake and food choices. Nonetheless, the professionals responsible for developing food were not included in this debate, so it is not yet a complete or accurate guideline.

To be sure, an egregious conceptual mistake about processing terminologies has been made in the development and use of misleading NOVA food classifications, and these are provoking misinformation and misunderstandings. Practicality is a necessity imposed nowadays. In a dynamic multicultural society, it is impossible to live without the industry presence and accurate scientific technologies to maintain them. Unfortunately, the love of the cooking act is not enough to destroy microorganisms and toxins; unit operations are required. There is no way to move back in society's evolution and change this reality. The FSTE professionals and the food industry are now challenged to reinvent themselves by considering social drivers. Such achievement requires that all the food industry professionals and public policies developers must focus more on the anthropological perspective. Besides its physiological role, food is also an arena of

feelings, insecurities, beliefs, and political actions. To improve health, understanding and treat the consumer as a human being is also essential. To be sure, FSTE has substantial scientific knowledge to help industries to guarantee high standard of quality for processed foods.

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CHAPTER 2

Food Processing: An overview and the links between safety, security, supply chains and NOVA classification

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Submitted to the Journal of Cleaner Production, 2022.

2.1. Abstract

The human diet changed continuously throughout the history of the humankind. Nevertheless, in the last 200 years the world experienced more important changes in diet and lifestyle. In an urbanized and industrialized world, people now spend more time out and, as a consequence, eating has begun to demand practicality. Nowadays, food can be accessed in food services, restaurants and supermarkets; it is no more cooked only at home by mothers or grandmothers, as in the past. With scientific and technological advancements, a huge diversity of food can be consumed days or months after being processed, but this expressive change in a relatively short amount of time has created a space of distrust in functions that stems from a lack of knowledge about the origin and history of food. Food is a complex field that involves emotions. People – including scholars – did not have enough time to assimilate the complex issues involving food, so its implications on health and moral values were neglected. Moreover, in times of high speed and overload of information, boosted by the absence of food system transparency, it is possible to find mistakes in food concepts even in the academic arena. This article aims, therefore, to reflect on the improvement provided by the food industry and FSTE knowledge on food safety and security, and demystifying some beliefs that involve food processing, additives, quality and sustainability, as well as asking for more dialogue, interaction and synergy among different food knowledge bases.

Keywords: processing food, industrialized food, homemade food, short chain, food additive, food system

2.2. Introduction

In the past age the world was surrounded by deaths due to foodborne disease (SATIN, 2014). Indeed, historically, food was an element responsible for crises and pandemics resulted from unsafe conditions or insufficient amount of food production (CONTRERAS and VERTHEIN, 2019; SATIN, 2014). In addition, even nowadays, while food is an element of demonstration of power, starvation has been used as well as a weapon (Amorim et al., 2022a). Since the Industrial Revolution, due to scientific and technological advancements, this reality could change when the food industry emerged and moved from batch to continuous processing, which allows an expressive scaling up in the amount of production of microbiologically safe and nutritious food per hour that

has a longer shelf life and is easy to be transported (AGUILERA, 2006; AMORIM et al., 2022a; FLOROS et al., 2010; SATIN, 2023). Nevertheless, campaigns against food industry have raised and some current usage of terms such as “processed” or “ultra-processed” foods, according to the NOVA classification, which are incorrectly giving a pejorative meaning to industrialized foods (AMORIM et al., 2022a,b; KNORR and WATZKE; 2019). This kind of mistake is also present in some Food Based Dietary Guidelines (FBDG), which are governmental documents developed to improve health and sustainability and are meant to educate people in their food choices (AMORIM et al., 2022a; KNORR and AUGUSTIN, 2021; KNORR and WATZKE, 2019).

The NOVA classification is categorized in four groups (MONTEIRO et al., 2019): 1) Unprocessed and Minimally Processed foods; 2) Processed culinary ingredients; 3) Processed foods; and 4) Ultra-processed foods. Fresh, squeezed, chilled, frozen, or dried fruit and leafy and root vegetables; powdered or pasteurized milk; fresh or pasteurized fruit, vegetable juices, and plain yoghurt; coffee, among many other, have been classified in the group 1; vegetable oils; butter; sugar; honey, salt were classified in the group 2; canned food; unpackaged breads and cheeses, among others, are in the group 3; and convenience food in general, such as packaged breads, margarines, milk drinks, infant formulas, etc, are classified in the group 4 (MONTEIRO et al., 2019). Nevertheless, this relation of classified foods has changed over the years (GIBNEY, 2019). This classification is based on amount and/or types of ingredients and additives added during food formulation, not on unit operations applied during processing (PETRUS et al., 2021).

Regarding animal products, for example, the NOVA classification considers, e.g., yogurt without sugar as MPF, and yogurt with sugar added as ultra-processed food. Sugar added is part of the product formulation, which there is no relation with process parameter (AMORIM et al., 2022a); so, this argument does not make sense from the Food Science, Technology and Engineering (FSTE) viewpoint (AMORIM et al., 2022a; AZEREDO and AZEREDO, 2022; BOTELHO et al., 2018; PETRUS et al., 2021). Therefore, besides the process conceptual error, the NOVA classification mistakenly mixes the concepts of formulation with process (BOTELHO et al., 2018). Additionally, fresh meat is considered by the NOVA authors as MPF, showing the absence of knowledge of the rigor mortis process, which transforms muscle (raw material) in meat (processed food). Thus, it is not so easy to consumers, and even for food experts, to classify foods according to NOVA

(BOTELHO et al., 2018, SARMIENTO-SANTOS et al., 2022). Monteiro et al. (2022) related that the concept of processing, even from NOVA classification or FSTE definition, has not clearly understood by the Brazilian population, which demands necessity of efficient food education, especially in the basic education. Moreover, the NOVA classification, adopted by the Brazilian FBDG, mistakenly ignores the fact that meals made at home or in restaurants can be considered also as processed (AGUILERA, 2018; AMORIM et al., 2022b; KNORR and AUGUSTIN, 2021; PETRUS et al., 2020), and this is a conceptual error in oversight.

Additionally, the NOVA classification also disregards the social improvement proportionated by the food industry as applying a huge unit operations and technologies on food processing which allowed the production of a bigger quantity of transportable safe products. Processing, especially at industry, is a powerful tool to achieve food safety and food security. Moreover, food processing can also improve nutrition (such as fortified products by encapsulation technology, e.g.) (AMORIM et al., 2022b; NORDHAGEN et al., 2022). Food safety, food security and nutrition are intrinsically connected (WHO, 2022). Indeed, food science and technological developments are strategic tools to save lives and increase the quality of life. The access to adequate food is a universal, constitutional and multidimensional human right advocated by the United Nations (FAO, 1990), so ensuring this right and making accessible safe, nutritional and pleasant tasting products is the main purpose of the Food Science, Technology and Engineering (FSTE) professionals. Obviously, the food system is not perfect, but ignoring its advances is similar to regressing to the medieval age.

To be sure, food safety, food security and nutrition are also key-points to the food supply chain (FSC). The FSC, including producers, processors, logistics and distribution, and retail and customers, all ensure that food products are produced in sufficient amounts and with adequate controls on quality and safety so that they are widely accessible to consumers (NORDHAGEN et al., 2022), no matter their geographical or agricultural conditions. This humanitarian role is the major duty of the FSC. In this way, the policymakers should work to improve the food system and not to promote campaigns against industrialized food. This article aims to reinforce the food safety and security improvements proportionated by food industry. Furthermore, it intends to demystify some popular beliefs stimulated by NOVA classification, asking for more dialogue, interaction

and synergy among the various public food managers, who are mainly the FSC members, health, social sciences professionals and policymakers.

2.3. Is the NOVA classification suitable to the current food reality? The milk and others case study

In the last 200 years the world has experienced an incredible growth in the food industry that has made possible the production of thousands of units of safe, nutritious and tasty food products per hour (AGUILERA, 2006). This phenomenon evolved through the applications of chemical engineering concepts in food line production by Food Engineering (mass, energy and heat transport phenomena, equipment and packaging design, etc.) (AGUILERA, 2006; SILVA et al., 2018) and the scientific development of microstructures, which allowed extended shelf-life and modified food textures by the controlling of water activity and glass transition in food conservation. Moreover, encapsulation technologies introduced vitamins, minerals, antioxidants, and other nutritional or not components, and the innovations of stable emulsions helped produce sauces, pasta, ice cream, break-fast cereals, etc. (AGUILERA, 2006, AMORIM et al., 2022b). Notably, these science and technological improvements promoted health, social, economic and civil society improvements (AMORIM et al., 2022b; GRACIA-ARNAIZ, 2021) and have provided long term safe food access to all, especially those who live in unfavorable agricultural conditions or have restricted geographical access. These developments also sparked the emergence of new businesses (GRACIA-ARNAIZ, 2021; SILVA et al., 2018) that grew employment and improved the economy (SILVA et al., 2018).

The extensions of food access can be easily noticed by analyzing the different storage conditions and the rise in shelf-life of milk (Table 1). Consumption of raw milk is not recommended because of its high microbial load which can include pathogens and result in foodborne disease[1] (KONTOMINAS, 2019; WALSTRA et al., 2006), but when it is pasteurized, it can be safely consumed, generally for up to 6 days, under refrigeration. If microfiltration technology is also utilized, the shelf life can reach 20-30 days, also under refrigeration. Further, if the UHT (ultra-high temperature) unit operation is

[1] Tuberculosis and Q-fever are example of foodborne disease provoked by spoilage microorganism, and *Listeria monocytogenes*, *Salmonella*, *Staphylococcal mastitis*, *E. coli*, *Coxiella burnetii*, etc are some of pathogens that can be present on raw milk (KONTOMINAS, 2019; WALSTRA et al., 2006).

employed (the most severe thermal treatment associated with the aseptic filling technology) the shelf-life is then extended to 6-12 months with storage in ambient temperatures (KONTOMINAS, 2019). Finally, if the milk's water content is withdrawn by spray drying (after pasteurization), the period for safe consumption rises to 2 years, also in ambient temperature storage (KONTOMINAS, 2019; Rosenberg, 2020; WALSTRA et al., 2006; WANG and LEE, 2019). Additionally, before these unit operations being applied, the lipid globules are homogenized with a goal to improve digestibility and stability of the final product (WALSTRA et al., 2006). Examples with different foods, such as palm hearts and chocolate, among others, were presented by Floros et al. (2010), Aguilera (2018), Silva et al. (2018) and Knorr and Augustin (2021).

Given this example and extrapolating and enlarging its scope to the food industry's focus on nutritional/medical areas, modern technology has developed a wide range of delicious products to satisfy and to attend people with food allergies (gluten, lactose, etc.) and heath limitations (diet and light products). The evolution of specialized product innovations is remarkable and extremely important to the assurance of food safety and food security, nevertheless it was ignored by the NOVA classification. Moreover, according to the NOVA classification, all products shown at Table 1 (pasteurized, UHT and powdered milk), despite having different process parameters and intensity, are considered minimally processed food, which in terms of the processing requirements, are not justifiable. Minimally processed foods (MPF), as considered by the FSTE, are fruits and vegetables generally washed, cut, waxed, sanitized, packed, refrigerated i.e., ready and safer to eat in its natural form (AMORIM et al. 2022a; AZEREDO and AZEREDO, 2022; PETRUS et al., 2021). Petrus et al. (2021) highlights that powdered milk cannot be classified as MPF because it requires high quantity and intensity of unit operations, involving a huge energy consumption. Therefore, by the lens of food processing, only by analyzing the milk classification, which is a nutritive product vastly studied by the FSTE, it is possible to realize that NOVA classification has an unacceptable process concept mistake and cannot be present in any governmental documents. In addition, the NOVA classification also considers coffee as MPF, in spite of the roasting stage being a high intensity unit operation. Furthermore, a food classification must consider the economic-social reality of a country as well as the vast number of foods, edible plants and animals, numerous processes worldwide and societies.

Table 1 – Milk shelf-life variation in order to the process and storage conditions.

	Unit operation (UN)	UN parameter / further technology	Storage	Packaging	Shelf-life
Milk	Pasteurization[1]	75°C / 15 seg.	Refrigerated (~ 4°C)	HDPE, PET, polycarbonate (PC) and LDPE	~ 6 days
		75°C / 15 seg. + Microfiltration	Refrigerated (~ 4°C)	PET	20 – 30 days
	UHT[2]	145 ºC / 4 -5 seg. + aseptic filling	Ambient temperature (<43°C)	PET, cardboard multilayers	~ 12 months[3]
	Dry (powdered)	Drying + aseptic filling	Ambient temperature (<43°C)	Metal can	0.5 – 2 years[4]

[1] High temperature, short time – HTST
[2] Ultra-high temperature
[3] Considering the package is closed, once the package is opened the product behaves like pasteurized milk
[4] Depending on the lipid ic content. With the same packaging, generally, 0.5 years to whole milk and 2 years to skimmed milk
PS. The shelf-life also varies in function of the pigmented (or not) packaging, besides the microbial load of the raw milk and amount of fat content of the final product.

Source: KONTOMINAS (2019), WANG and LEE (2019).

2.4. Is processed food synonymous with industrialized food?

Individual businesses no longer compete as solely autonomous entities, but rather as supply chains, meaning the success of a local company will depend on the management's ability to integrate the company's intricate chain of business relationships, from end user through original suppliers that provide products, services, and information that add value for customers and other stakeholders (LAMBERT, 2014). According to Chopra and Meindl (2013), the supply chain refers to "all parties involved, directly or indirectly, in fulfilling a customer request. It includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves". In this way, supply chain is a strategy that involves multiple operations (in parallel or in series), previously designed and planned, that involve flows of materials, information, energy, monetary, among others, which can be convergent or not, and which are managed to transform an input into a value product available to the customer. Each member of the FSC has different expertise and duty in spite of the same goal: fulfill customer requests and maximize the overall value generated (CHOPRA and MEINDL, 2013).

All stages of the FSC involve food processing. Indeed, independent of the operation or a goal (washing, roasting, slicing, foaming, etc), all human food is processed

(AGUILERA, 2018). Even culinary ingredients, before reaching consumers, retails or restaurants, have to be produced and processed, preferably on an industrial scale for several reasons: efficiency and therefore the final price, sustainability and optimal use of resources and handling side streams thereof, safety and standardized quality (nutritional and functional) (AMORIM et al., 2022a,b; KNORR and AUGUSTIN, 2021). Processing turns agricultural commodities into edible, safe, delicious, and nourishing products (AGUILERA, 2018; KNORR and AUGUSTIN, 2021). Generally, the agri-sector is responsible for supplying raw materials (cattle, pigs, poultry, fish, meat, raw milk, sugarcane, corn, cassava, wheat, soybean, among many other, including and their by-products) to the food industry and, eventually, also for commercializing it with other stakeholders (retail, restaurants, foods franchises, food service in general, and even with the customer) (RICCABONI et al., 2021). In this way, the agri-sector is responsible for cultivation of animal, fruits, vegetables, grains, in addition to improving soil conditions that can interfere with the commodities commercialization and safety conditions. Moreover, biotech has emerged as a tool capable of converting biomass in edible food (Mok, et al., 2020), and this kind of food was not considered at NOVA classification.

The Food Industry, in turns, could be viewed as being composed by 1st and 2nd levels of transformation. The 1st level is the ingredients industry (sugar, starch, flours, additives, chemical components, etc) and MPF (fruits and vegetables), as defined by FSTE (AMORIM et al. 2022a; PETRUS et al., 2021). The 2nd level, in turn, is responsible for applying the sequence of unit operations[2] and methods of preservation [3]that transform raw materials and ingredients, supplied by the agri-sector and the 1st level of transformation, into a value-added product, besides reducing post-harvest losses (CHUNG et al., 2022; KNORR and AUGUSTIN, 2021). In other words, the 2nd level provides processed food (PF). Examples of products supplied by the 2nd level of transformation are processed milk (whole, skimmed, dehydrated, powdered), cheeses, yogurts, ice cream, processed meats (fresh meat, sausages, bacon, ham, etc.), bakery products, beverages (juices, tea, soft drinks, etc.), coffee (grain, powdered, capsules, etc.), granola, sauces, cookies, chocolates, candies, among many others.

[2] Until now, the main unit operations applied to guarantee food safety involves thermal processes (pasteurization, ultra-high temperature, cooking, etc.), despite the growth of the non-thermal treatment technologies. Additionally, there are other strategies employed by the manufacturing industry to achieve food safety, such as reducing the water activity by adding additives; however, the act of adding something in food is related to the formulation of the product, and not to the process involved on it. Process and formulation are different concepts (AMORIM et al., 2022a).

[3] Methods of preservation applied in food industry can be understood as formulation development (use of additives and ingredients to control pH, water activities, etc.), appropriate packaging (especially the active one, with good mechanical and barriers properties), cold chain, the hurdle technologies (different methods of food preservation used in association), and etc.

These food products can be designed by chefs, but the processes are still dimensioned by the FSTE professionals, especially by the Food Engineer, and also Chemical Engineers (R&D – Research and Development). So briefly stated, the 1st level of industry transforms and provides ingredients and MPF to other stakeholders (including the customer), while the 2nd level of industry transformation supplies the final product (processed) that is generally accessed by customers in the supermarkets. It is important to highlight that, depending on the food segment, the agri-sector also can be classified as a manufacturer. For example, with meat or dairy products, which have their process started on the farm, the phases for slaughter, cutting, cleaning, sometimes to smoking, drying, etc. and are finally made into meat products. For some dairy products, thermal processes are used to separate components (casein, whey protein, etc.); formulations are designed into final products (cheeses, yogurts, cream cheese, etc.), then packaged and distributed for sale. Notably for many animal products, it is possible all these stages (production and processing) are performed by the same enterprise.

After processing, the products are ready for consumption, but not yet necessarily physically accessible, i.e., closer to customers. So, they must be distributed[4] and commercialized[5]. During the commercialization, the food products (processed or minimally processed) are available to customers/eaters at the retail or food services. In this stage, supervise the sanitary conditions of the vehicle and equipment used in transportation, keeping adequate temperature control and physical conditions of the vehicle, which must be free of visible contamination evidence, and many others actions and procedures (that includes personal trainings) are mandatory to guarantee food integrity and safety during transportation (FDA, 2017). Within the function of food services, there are restaurants, fast food franchises, cafeterias, bakeries, etc., each with their own purpose and identity for offering food solutions to the customer (SILVA et al, 2018). Whereas Food Engineering aims to provide several diversities of food in industrial scale for the customer to access in the retail segment, the restaurants, in turn, aims to provide processed food (also ready-to-eat) for the customer to consume at a specific place or, as happens more recently, in a delivery service strategy, which does not guarantee an

[4] Distribution is staged between the food production/process and the point of sale in different geographical locations. Distribution and commercialization also occur between the other stakeholders in the FSC, not limited, therefore, to connect the 2° transformation level and consumer/eater. The agro raw material, the foodstuff or ingredient, for example, also needed to be delivered to the 2° level of transformation industry. In this case, the final consumer is the industry, and not the eater.

[5] As FSTE professionals, we do not consider the concept of "ultra-processed" food. By mixing process (sequence of unit operations) and formulation (ingredients/additives) concepts, the NOVA classification represents a serious conceptual mistake. The FTSE recognizes only processed and minimally processed food concepts (AMORIM et al., 2022a,b).

extended shelf-life concern (AMORIM et al., 2022a). Due to the similarities between food industry and restaurants regarding the aim to offer processed food to customers, Riccaboni et al. (2021) considered the restaurant segment to fall within the definition of "food processors", i.e., into the transformation industry stage. Moreover, the function of gastronomy expertise, composed by the "Chefs" of cuisine, involves food management through culinary techniques (traditional or not) connected to culture and sculptured by etiquette (MUTLU and DOGAN, 2021). Therefore, in this paper, "Gastronomy" is mentioned as a food production in homemade or restaurant scales for three reasons: The process is applied with equipment and in a more similar scale as used at home; the unit operations are controlled (generally) with no standard by a person and not by an equipment/sensor, and finally, the consumption will certainly occur in some hours, and not weeks or months. Additionally, we can also consider different food industries, fast food franchises and restaurants (AMORIM et al., 2022b). Food industry companies process food in industrial plants. Restaurants process food in kitchens (as home or even industrial kitchens) (KNORR and AUGUSTIN, 2021), and franchises, generally, mix industrial operations philosophy (fordism) with the restaurant purposes (offer ready-to-eat food with short shelf-life) (AMORIM et al., 2022b), and in the latter case, foods are usually processed in industrial kitchens.

Actually, the food industry is nothing more than an adaptation of the kitchen on a large scale. Aguilera (2018), in his article "Relating Food Engineering to Cooking and Gastronomy", explain that heat transfer unit operations, such as pasteurization, refrigeration, drying, and freezing are also made at home as boiling potato, cooking pasta, braising a vegetable, frying a cassava/potato, grilling/barbecuing a meat, or even refrigeration and freezing any food; however, the FSTE professionals using the Fourier equation to obtain a complete and standardized starch gelatinization of potato during the boiling, for example. Mass transfers such as salting, brining, smoking, maceration, marinating, etc., are also frequently made in homemade cooking. Moreover, heat and mass transfers generally occur simultaneously, e.g., in dehydration (fruits or vegetable chips, cake/bread baking, e.g.), extraction (coffee, tea) (AGUILERA, 2018). Aguilera (2018) yet describes many other unit operations linked to momentum transfer commonly made in the kitchen, such as whipping a cream, kneading a bread, cutting/slicing fruits and vegetable, grinding (meat, spices), blending (juices), emulsifying (mayonnaise), and many others. In addition, nowadays, even with food industry presence, it is easily possible

to find many recipes of traditionally industrialized products to prepare at home, such as homemade yogurt or mayonnaise. However, in homemade productions, it is harder to obtain a standard product and to calculate Q10 parameter, which is the parameter that describe the variation of a component interest when the temperature is increased by 10°C (ORTEGA-RIVAS, 2010), to obtain a safe shelf life. Moreover, in homemade productions it is also harder to guarantee food safety because the procedures are unknown, eventually diversified and made by a person not necessarily specialized (Farias et al, 2020), who despite having good intentions, can unconsciously make a mistake. Furthermore, safer unit operations such as commercial sterilization, requires a sterile environment, which hardly can be correctly made at home. Therefore, as exhaustively explained by Aguilera (2018) and ignored by NOVA classification, process parameters occur at home, industry, laboratory and restaurants.

Finally, the last FSC stakeholder is the customer, who will buy and consume the result of the work of all previous members (KUMAR et al., 2022). The customer's duty is, through their very choice of consumption, to determine food system trends and production variety, and hopefully to reduce food waste by planning food purchasing (i.e., buy items that really need and in enough quantity), avoiding inadequate packaging sizes, buying impulsively, cooking only the amount that certainly will eaten (avoiding preparing oversized meals), cooking creatively, storing in the correct form (appropriate temperature, packaging with good wrapping, etc), and not throwing away good quality food conditions with disadvantageous appearance (PRIEFER et al., 2016). Given this, the customer guides the decision-making of all other FSC members and has an important role in sustainability matters.

2.5. The size of the chain does not necessarily mean better quality

The Short Food Supply Chains (SFSC) has emerged as a customer response to the disconnection promoted by the monopoly power of large agri-food manufacturers that seek to control most parts of the Food Supply Chain (FSCs) (ASIOLI et al., 2017; GONZALEZ-AZCÁRATE et al., 2022; JIANG et al., 2020; THOMÉ et al., 2021). This disconnection implies that consumers know less about how food is produced/processed and, as a consequence, have less emotional connection to it (GONZALEZ-AZCÁRATE et al., 2022). These customers are generally searching for the history of food products, which involve the origins, kinds of processes, possible chemical additions, and concerns

about ecology, health and animal welfare (ASIOLI et al., 2017; AOUINAIT et al., 2022; SELLITTO et al., 2018; THOMÉ et al., 2021). Being viewed as a more ecological and healthier food system for this customer (SCHMITT et al., 2017), the SFSC represents a form of activism (AOUINAIT et al., 2022); however, the size of the chain does not necessarily determine a higher sustainability of health (KISS et al., 2019). Indeed, even the impact on social, economic and environmental factors are highly dependent on the product and the supply chain strategies, which can involve FSC or SFSC (ENTHOVEN and BROECK, 2021). In addition, local products can be more expensive than the one offered by the traditional supply model (AOUINAIT et al., 2022), and it must be considered.

From these frames of references, SFSC's focus is on generating alternatives and opportunities for rural development, and the chain, through an approach that sees alignment between production and consumption, is based on local and regional characteristics, as well as tradition in a shortening of the relationship chain (THOMÉ et al., 2021). The short chain definition is still unclear (ENTHOVEN and BROECK, 2021; PACIAROTTI and TORREGIANI, 2021; SCHMITT et al., 2017). The SFSC is understood as a closeness relationship between stakeholders (CHIFFOLEAU, et al., 2019; PACIAROTTI and TORREGIANI, 2021; SELLITTO et al., 2018); however, closeness can be conceptualized in terms of political or geographical boundaries, and social relations between producers, processors and consumers (which can be measured in time or distance), supply chain size, number of intermediaries, among others (GONZALEZ-AZCÁRATE et al., 2022; PACIAROTTI and TORREGIANI, 2021). To be sure, this closer relationship does not necessarily mean higher food safety or security. The SFSC can involve formal or informal relationships based on trust between stakeholders (farmer and customer, mainly) about small or medium entrepreneurial and traditional and/or regional products that are popularly considered more natural[6] and healthier (GONZALEZ-AZCÁRATE et al., 2021; THOMÉ et al., 2021).

[6] The concept of natural food has been used to refer to biologic origin products (i.e., non-processed food) (BATTACCHI et al., 2020); however, according to Rozin (2005, 2006; ROZIN et al., 2012), there is no scientific definition of natural products. Generally, lay people think nature is safe and benevolent; however, these beliefs are often wrong. In the lay mind, naturalness is destroyed by almost any process that involves human intervention (SCOTT and ROZIN, 2020). Moreover, according to the food process concept (AMORIM et al., 2022a), it is almost impossible to consume some food that has at least not one unit operation application. Traditional foods such as cheese, wine, beer, and some kinds of bread are processed and do not exist naturally in nature. Vegetables such as potato, sweet potato, zucchini, cabbage, eggplant, as being cooked even at home, are also processed but on a homemade scale. Fruits and leaves, such as apple, pineapple, papaya, watermelon, lettuce, broccolis, if bought in a market or fairs, are minimally processed food (cut, washed, peeled, sliced, juiced, removed inedible par, etc.). Therefore, meaning of natural food as a synonym of biologic origin food is a mistake. The readers interested in studying the concept of naturalness throughout the food supply chain, are invited to read Battacchi et al. (2020).

Furthermore, different that suggested by NOVA classification, the SFSC itself does not necessarily mean a better product quality (KISS et al., 2019; PACIAROTTI and TORREGIANI, 2021) or a sustainable chain (GONZALEZ-AZCÁRATE et al., 2022), depending on the product and the way the product is produced, processed and transported (ENTHOVEN and BROECK, 2021; SCHMITT et al., 2017). Actually, despite reducing the distribution distance and when taking into account that the logistics in SFSC will be done with a smaller quantity of products per vehicle, it can be considered as less sustainable than a global chain (GONZALEZ-AZCÁRATE et al., 2021; SCHMITT et al., 2017). Additionally, food transport is not considered as the major driver to climate change (ENTHOVEN and BROECK, 2021; KISS et al., 2019). As comparing the environmental impact of zero-miles production (or zero- kilometer production), urban agriculture, and traditional supply model, Urbano et al. (2022) found that the distance travelled by the product is less important than the efficiency of the transport. Both urban agriculture and zero-miles are considered local production, however, zero-miles refers to the production of food that is consumed less than 100 km from the production area (URBANO et al., 2022). Shifts in diet could be more efficient to the environment than simply small distance implementations (SCHMITT et al., 2017). Moreover, even in local productions, many ingredients and inputs (such as animal feed, salt, oils, enzymes, yeast, etc) are globally produced, which raises the overall product distance (SCHMITT et al., 2017). On the other hand, local productions generally have bigger biodiversity than global production, and it is intensified by considering rates of deforestation (SCHMITT et al., 2017).

In viewing SFSC through food security and food safety perspectives, overall local products are usually produced in very small quantities and commercialized locally (SCHMITT et al., 2017). At the same time, SFSC can imply a local food supply, so it might be unworkable in agriculturally disadvantageous regions; therefore, it cannot be overly generalized. Additionally, it is known that small producers have hygiene regulations and investment capacities as a barrier (SELLITTO et al., 2018; SCHMITT et al., 2017), which can affect food safety assurance, and as a consequence, also food safety maintenance. Short and global food supply chains should not achieve different levels of food safety standards (BUSCAROLI et al., 2021). To improve safety, independent of the entrepreneurial classification, traceability, clear legislation, transparency and good technological tools are essential (KUMAR et al., 2022). This diversity of commercial flow can be advantageous to the economy and local food security; nevertheless, from the

food safety point of view, without a strong and established regulatory system, it can represent a risk to maintaining public health policies and trigger the return of the foodborne diseases, such as salmonellosis, poisoning, among others (ORTEGA-RIVAS, 2010).

2.6. Food composition and the safety matter

Water and food are naturally a vehicle of microorganisms (GALLO et al., 2020; MENDONÇA et al., 2020). Recently with the blooming of short chain trends, customers and producers have become directly connected. This face-to-face interaction promotes a stronger feeling of trust in the customer regarding food safety, which is sometimes overestimated (BUSCAROLI et al., 2021). To guarantee food safety, the FSC has to follow rigorous hygienic sanitary rulers established and certified by regulatory agencies (SATIN, 2023). It is known that food microbial contamination can also occur from soil, wind, water, dust, etc. (MENDONÇA et al., 2020; PRACHE et al., 2022). Mycotoxins, for example such as Aflatoxin, which have high potential for genotoxicity, carcinogenicity and immunotoxicity, are naturally produced as metabolites by a toxigenic fungus (*Aspergillus flavus*) in peanuts, maize, tree nuts, cereal grains, e.g., in storage conditions (MISIOU and KOUTSOUMANIS, 2022; MOY, 2014). Similarly occurs with *Fusarium* mold, responsible for many deaths in Europe, which are closely associated with the consumption of plants, roots, cereals, grains and legumes contaminated, e.g. (SATIN, 2014). In addition, even in urban agricultural, pathogens microorganisms such as *Escherichia coli, Salmonella enterica, Listeria monocytogenes, Staphylococcus aureus*, and *Campylobacter serovars* can be found in the plant's growing media (soil, nutrient solutions, etc., mainly if compost has been used as nutrient source), edible parts of crops, vegetable organisms and irrigation water (BUSCAROLI et al., 2021). By the contrary that affirmed by NOVA classification, the love of the cooking act cannot eliminate food microorganism and, consequently, the diseases provoked by them; sanitary hygiene control and adequately processes parameters application are crucial to achieve food safety (AMORIM et al., 2022b), and sanitary rigorous controls is essential in all the supply chain stages, from the farm to table. Given this, food safety is connected to the procedures realized on it since the plantation, which implies real public health concerns and were ignored by the NOVA classification authors.

The food industry, by adequately applying various critical unit operations (such as sanitization, pasteurization, sterilization, ultrafiltration), prevents the customer from ingesting this possible microbial contamination and becoming ill (FLOROS et al., 2010; ORTEGA-RIVAS, 2010). This is exemplified with milk products in Table 1, when thermal processes are mainly responsible to suppress and eliminate foodborne diseases, such as provoked by pathogens such as *L. monocytogenes* or *Salmonella* (KONTOMINAS, 2019; WALSTRA et al., 2006). Disease such as Tuberculosis was controlled after the 1970 decade, when raw milk commercialization was prohibited in some countries and many sanitarians public policies in all the FSC was implemented, as for example in Brazil (HIJAR, 2007), USA and Canada (SOCKETT, 2014). In Brazil, a few decades ago, the pasteurization of milk was made at home, but not necessarily with the adequate binomial time-temperature appliance and food safety assurance. Although there is a popular belief that homemade food is safer, around 80% of the food intoxications occur with food processed at home (Al-SAKKAF, 2013; FARIAS et al, 2020). Regarding milk products, some artisanal processor products claim for the raw milk usage, as their precursors used to (WILKISON, 2002); however, it can bring back diseases already controlled. Tradition, innovation and practicality are mixed into modern cultures (AMORIM et al., 2022b) and challenge food safety and economy (ARAGÃO et al., 2022).

Food Safety is one of the pillars of Food Engineering (KNORR and WATZKE, 2019). Whether at home or industry, despite to eliminate pathogens microorganism, thermal processes also can produce undesirable contaminants (MOY, 2014). Taş et al. (2022) explain that the production of contaminants during food processing, such as acrylamide (which have carcinogenic potential), is reduced when the product is processed by industry, in comparison with in the home. Technologies, such as addition of asparaginase enzyme in boiling water of sliced potatoes before frying or application of steam and a subsequent asparaginase enzyme of coffee beans, are capable to reduce in almost 60% of the acrylamide production (TAS et al., 2022), and it is not a common homemade practice. In fact, food contaminants are also monitored and measured, unlike in home cooking. Moreover, in the industry, a better selection of the raw material is possible (e.g. such as potatoes low in sugar, for less acrylamide formation). And from the sustainability point of view, a large-scale production does not necessarily mean a greater environmental load Silva and Sanjuán (2019).

Indeed, at home or at industry, and even in restaurants and food services, any transformation is considered a process, even with fresh products accessed in rural production (AGUILERA, 2018; PETRUS et al., 2020). Notably, the expressive improvement in food safety and food security shown in Table 1, regarding milk products – a nutritive product (WALSTRA et al., 2006) – would not be possible without the presence of the food industry. Moreover, it is unanimity into FTSE area that processes are not able to improve or recuperate raw material quality; therefore, a high level of hygienic-sanitary cultivation procedures during the agri-sector stage is crucial to guarantee good quality of raw materials and, consequently, of the final product (ALEKSIC et al. 2022). Additionally, it is important to clarify that failures and food frauds are different events, although both have negative potential food safety. Food fraud is an intentional failure aiming for economic gain, while a failure in itself is a mistaken procedure (VISCIANO and SCHIRONE, 2021). The responsible for finding and punishing these companies for the crime are the regulatory agencies of each country.

In the transformation industry, the FSTE professionals are responsible for huge and complex stages, which extend from the obtaining of raw material by the suppliers, until the commercialization of the final product at the retail (RICCABONI et al., 2021; SILVA et al., 2018). These professionals understand the chemical, physical-chemical, biochemical and microbiological food composition, as well as the unit operations and its control parameters, in addition to a large variety of technical manufacturing, which are applied on biological origin products that, even after process, can keep their metabolic activities (KOSTAROPOULOS, 2012). Further, FSTE professionals can be also responsible to develop the product formulation[7] and to handpick the packaging and determine the conditions of the storage and the product shelf-life (RICCABONI et al., 2021). All of these aspects are important to guarantee food safety and longer shelf-life; therefore, the agri-sector and the food industry are complementary, however, still independent.

Furthermore, food safety issues also involve the product compositions in all the supply stages, i.e., the natural and artificial chemical components used during the agri and industrial sector. In the agri-sector this includes pesticides (insecticides, herbicides, and fungicides), heavy metals, fertilizers, veterinary drugs (antibiotics, medicaments, etc),

[7] The product formulation is the variety and proportion of ingredients and additives that will compound the final product. In the homemade words, formulation is the recipe (AGUILERA, 2018). The formulation is developed after and according to the customer's claims and necessities evidenced during the market analysis (which is the most important guidance to researcher and developers on products in the food industry).

among others (MISIOU and KOUTSOUMANIS, 2022), and in the food industry it is most related to the ingredients and additives added in the formulation step during the food process, or in the packaging, or the migration of some chemical component to food (GEUEKE et al., 2018). The food additive usage is important to guarantee food access for a longer time, reducing spoilage kinetics, and with that, decreasing food loss and waste (GOMES et al, 2020). For example, nisin (a peptide), a natural food additive added in dairy products, beverages and meat, etc., is used to avoid microbial growth, and consequently possible foodborne diseases and losses by spoilage. Also, catechin, ascorbic acid (vitamin C) and α-tocopherol (vitamin E) are additives widely used as antioxidants in many foodstuffs (CAROCHO et al., 2015). In this way, food additives represent an important tool in the food safety and security effort.

Regarding the industrial stage, ingredients and additives are added in food product formulation as processing aids and to enhance flavor as well (KNORR and AUGUSTIN, 2021). There is no formal distinction between ingredients and additives. Basically, additives are "generally recognized as safe" (GRAS) chemical compounds added in food formulation in no more than 1%, whereas ingredients can be multi-component products and there is no limitation of concentration (FLOROS et al., 2010). The European Community legislation defines additive as "substances that are not normally consumed as food itself but are added to food intentionally for a technological purpose" (EC, 2008). The FDA, in turn, defines additive as "any substance for the intended use of which results or may reasonably be expected to result, directly or indirectly, in its becoming a component or otherwise affecting the characteristics of any food" (USC, 2007). The approval and limitations of food ingredient and additive usage is regulated by the regulatory agencies of each country.

Usually, the additives are classified in preservatives (antimicrobial, antioxidants and antibrowning), fortifiers (nutritional additives), flavorings (include sweeteners and flavors enhanced), colorings, texturizers (emulsifiers, thickeners and stabilizers), and others (CAROCHO et al. 2015). These are used in the industry to preserve or synergistically optimize some ingredient's sensorial quality (flavor, taste or texture), modifying intrinsic characteristics (pH or water activity) and, as a result reduce the deterioration food kinetics, increase the shelf-life to consumption, and reduce loses post-harvest and avoiding illness (FLOROS et al., 2010; GOMES et al., 2020; ZEECE, 2020).

All of the latter are representative and important tools used to guarantee food safety and improve food security and sustainability.

Although additives usage has been studied for decades, some potentially dangerous effects towards human health are still being discovered for many of them (CAROCHO et al., 2015; GALLO et al., 2020). Additives with phosphorus (such as polyphosphate, used as thickeners and emulsifiers in dairy products, e.g.) can cause heart diseases or kidney damage (GALLO et al., 2020). Sulfites and bisulfites (preservatives and antioxidants) and the sulfur dioxide present in jams, juices, and wines (CAROCHO et al., 2015; GALLO et al., 2020), which are also used as a spray in restaurants to prevent oxidation of salads and fruit salads, can cause dermatitis, hypotension, abdominal pain and diarrhea, or, in worst cases, anaphylactic reactions and asthma attacks (GALLO et al., 2020). Nevertheless, some of these danger molecules are also naturally present in many foods. Salicylates, naturally present in nuts, berries, grapes, olives, and herbs, can cause chronic urticaria and bronchospasms or affect the gastrointestinal tract with colitis and diarrhea and have effects on the circulation or even cause anaphylactic shock (GALLO et al., 2020). Nitrites, which have their usage restricted by the EFSA in function of their carcinogenic effects, can be found in untreated fruit and vegetables (e.g., spinach) (CAROCHO et al., 2015) or even in mineral water (Ward et al., 2018). Moreover, the additive usage has been occurred for centuries in homemade productions (vinegar and salt, e.g.) (MOY, 2014), being it not an exclusive act of the food industry, as suggest by the NOVA authors.

In this scenario, the health professionals (nutrition, medical science, pharmaceutical, and similar) have an important role in improving health by making clear which component can represent damage to human health. They must analyze the food components that can harm or improve customer health (LU et al., 2022; MICLOTTE and WIELE, 2022). Usually, the dietary exposure assessment is related to the amount of a specific food consumed per day and the average individual body weight (JEDDI et al., 2022). In this way, understanding the dietary patterns of each culture is important to specify which component and in what quantity can be safely used by the agri-sector and food industry. Based on the analysis made by the health scholars, the FSTE will be able to identify and choose the best formulation component (ingredient and/or additive), both from a technological and health point of view, and a similar logic can be applied with the agri-sector; therefore, the agri, FSTE and health professionals have different knowledge

bases that are also complementary. In actuality, these fields comprise the food issues tripod.

2.7. The necessity of dialogue

The professionals responsible for food matters have inter and trans disciplinary formations. FSTE, Agri and Health knowledge bases, despite being technically different, are equally important, and one does not overlap the other. In order to describe some trans disciplinary phenomenon according to a more appropriate approach to their discipline, each field creates its own definition and terminologies, which sometimes are unknown or eventually inappropriate to other disciplines (CLANCY, 2022). These non-convergence among areas, in addition to the lack of comprehension about food concepts, has resulted in serious conceptual misconceptions and mistakes, such as those made by the NOVA classification' authors and also by the Brazilian Food-Based Dietary Guideline (FBDG) (MINISTRY OF HEALTH OF BRAZIL, 2015) regarding the definitions and concepts of the term "(ultra)processed".

In choosing a food classification which mixes processing and formulation concepts, this important public policy tool has not been correctly used, on the contrary, it has been considered to be wrongly educating and misleading by some authors (AMORIM et al., 2022a; KNORR and WATZKE, 2019; PETRUS et al., 2021). Moreover, according to Taş et al. (2022), by classifying food based on processing and not considering some processing contaminants that are formed during thermal processing from naturally occurring precursors in foods, such as acrylamide, furan, furfural, nitrosamines, heterocyclic amines, e.g., the NOVA classification has overlooked food safety risks, especially those resulting from homemade production. Additionally, NOVA orients people to avoid industrialized food in order to consume homemade; although, the production of these contaminants is significantly reduced when the process is made by industry under the controls of technological applications (TAS et al., 2022). Given this, the NOVA classification does not necessarily help in the role of food safety and food security. Food safety, food security, nutrition and dietary are interconnected (JEDDI et al., 2022), and a trans disciplinary work could be the best way to improve health and public policies tools. The readers interested in studying the NOVA classification are invited to consult Monteiro et al. (2019), among others, and those interested in understanding the FSTE viewpoint about "ultra-processed" food are invited to read

Amorim et al. (2022a), Galan et al. (2021), Knorr and Watzke (2019), and Petrus et al. (2021), among others, and further, those interested in understanding the process parameters in homemade production can read Aguilera (2018) and Knorr and Augustin (2021).

Food is more than fundamental for human health and survival; it is also a major source of pleasure and displeasure (ROZIN and HOLTERMANN, 2021). To achieve customer satisfaction and trust, food professionals and policymakers have to consider social-anthropological issues (AMORIM et al., 2022b). Rather than being viewed as simply a customer, the target audience must be recognized and understood as a human being with moral values, feelings, fears, insecurities, in addition to their health and economical limitations (AMORIM et al., 2022b; CHEN and CHAI, 2022). The decision to consume a food is moral (AMORIM et al., 2022b; BARBOSA and CAMPBELL, 2006; Contreras and Gracia, 2005; Rozin et al., 2019). Food consumption also implies "the absorption of their moral and behavioral properties" (BARBOSA and CAMPBELL, 2006; GRACIA-ARNAIZ, 2021; Rozin et al., 2019), besides the nutritional one. "We are what we eat", however, "we also eat what we are" (GRACIA-ARNAIZ, 2021). In this way, people eat what is allowed and accessible to their cultures (AMORIM et al., 2022b). Food professionals have the duty to promote wellbeing that respects personal choices and lifestyles as well as supplies good food solutions to people with all kinds of restrictions. To achieve healthiness, it is essential that each food professional understands this responsibility and acts accordingly within their area of expertise by working for symbiotic and constructive dialogs that benefit society. Food system transition requires a collective approach that involves different stakeholders, such as public authorities (including cities, rural and coastal communities), private sector, academics in diverse arenas, social partners and citizens across the food value chain (RICCABONI et al., 2021).

2.8. FSC and Public Policies

FSC and public policies are connected in many directions that encompass many economic, social, environmental, humanitarian and health issues. It is not possible to achieve a food chain that works for consumers, producers, climate and the environment without stronger governance (RICCABONI et al., 2021). Foodborne diseases do not occur as rampantly as in the past due to advanced science, food industrialization and legislation (CONTRERAS and GRACIA, 2005); however, cases still exist, and the most

affected are children under the age of five, the immune-compromised, the elderly, and pregnant women (WHO, 2022). As foodborne diseases overcharge health systems and impact negatively on economic productivity, safety has emerged as a global public health concern (JEDDI et al., 2022; Rivera et al., 2018). Even in natural products, "to be widely available as foods these 'natural', structures need first to be preserved" (AGUILERA, 2006); therefore, food safety is also connected to the economy (WHO, 2022), and it is related to processes.

In terms of food access, it is known that climate changes will especially affect the poor in the underdeveloped countries (AMORIM et al., 2022a; GRACIA-ARNAIZ, 2021; WHO, 2022). It is expected that several regions will experience unprecedented weather events impacting global food and nutrition security (ALLEN et al., 2019). Yet, nowadays, people with fewer resources still have a food consumption pattern limited in variety, quality and frequency (GRACIA-ARNAIZ, 2021). In spite of the developments in the food system, the modern world is affected by nutrient deficiencies (obesity and overweight pandemic in parallel to coexistent hunger/malnutrition) and significant food production losses (ALLEN et al., 2019; AMORIM et al., 2022a; GRACIA-ARNAIZ, 2021).

In order to achieve peace and prosperity, the Organization for Economic Cooperation and Development (OECD) highlighted 6 of the 17 United Nations (UN) Sustainable Development Goals (SDG) to governments and private agencies (OECD, 2022), in which success depends on the possibility of the large scale implementation of good public policies (UN, 2022b): (**2**) Hunger Zero, (**5**) Gender Equality, (**6**) Clean Water and Sanitation, (**9**) Industry, Innovation and Infrastructure, (**11**) Sustainable Cities and Communities, and (**16**) Peace, Justice, and Strong Institutions (OECD, 2022). Likewise, Desiderio et al. (2022), in their review about social sustainability tools and indicators for the food supply chain, showed relations between FSC and SDG, besides the numbers (**2**) and (**5**), and also (**8**) Decent Work and Economic Growth, (**10**) Reduced Inequalities, and (**12**) Responsible Consumption and Production.

Yet, to achieve sustainable food production, process and consumption, it is crucial to consider the entirety of the supply chain and all the actors involved at each stage along the way (DESIDERIO et al., 2022; KUMAR et al., 2022). The FSC, by working on food access, helps to decrease hunger, boost employment, and the development of new technologies. According to the UN, the world is at the limit of its natural resources, and

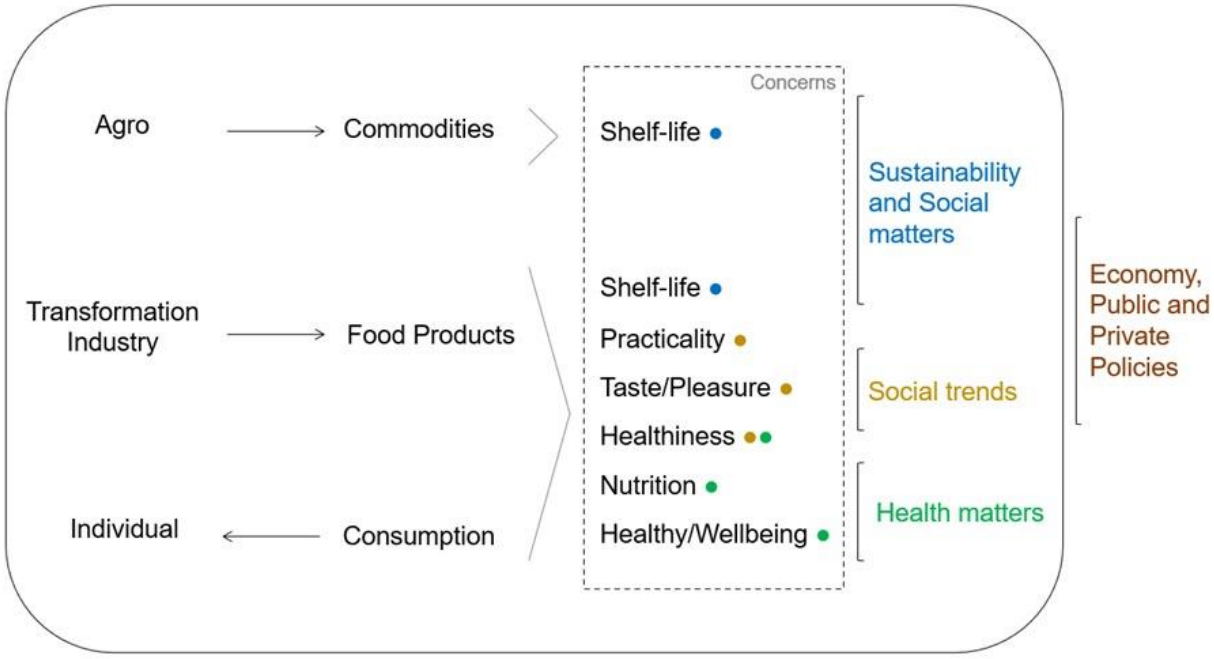
the next 3 years will be crucial to the climate change situation and the sustainable development goal (SDG) achievements (UN, 2022a). Nowadays, almost the entirety of food consumption is industrialized (CHUNG et al., 2022). In this way, the FSC must drive their efforts in a sustainable way, which means in a way to "sustain the economic, ecological and social system for human development" (CLANCY, 2022).

To achieve healthiness and the SDG, the FSTE, agri and health professionals should work together, contributing to the development of efficient public policies. Campaigns against the food industry and agribusiness have emerged ignoring the humanitarian improvement proportioned by them, such as increase in food production and access or a decrease in prices (ROZIN et al., 2019). For food access, price is a key element, even to consumers worried about health and nutrition (CHIFFOLEAU, et al., 2019). When money is limited, the option of an elected diet disappears, because generally fresh and organic food are more expensive (CHIFFOLEAU, et al., 2019; WAN, 2012) and policymakers have to consider it. Moreover, the food production system has to be more transparent and sustainable, but not be eliminated or ignored. The guarantees for a longer food shelf-life are important to reduce food loss and waste, and importantly, to reduce hunger and malnutrition. People who live in disadvantaged geographical locations also have a right to eat well and with diversity; however, food needs to arrive there in a safe condition.

2.9. FSC and Private Sector

Companies are driven by profit as their main objective with the responsibilities to maintain employment and monetary flow in addition to social and technological development. To achieve this, it is necessary to produce products according to the customer's needs, preferences and acceptance (AGUILERA, 2006; SILVA et al., 2018) while optimizing processes (reduce wastages, improve inputs negotiations, e.g., and many others). Currently, as shown in Figure 1, customers desire practicality, pleasure, nutrition, and wellbeing in all FSC stages (raw materials management, social and animal dignity as well as environment preservation), thus, some changes are needed (GRACIA-ARNAIZ, 2021; MATZEMBACHER et al., 2018; SILVA et al., 2018; WAN, 2012).

Figure 1 – Food system: main sectors and concerns



Source: the authors.

Recently surfacing in the slow food (versus fast food) movement, the clean label emerged as a customer desire. It means that customers prioritize the consumption of products with less or without additive/artificial ingredients, which were elaborated from mild processes and based on organic/environmentally friendly agriculture[8] (ASIOLI et al., 2017). In this way, rejection and feelings of mistrust can be aggravated by the lack of transparency from the food system and the consumer's non-familiarity with technical terminology (AGUILERA, 2006; ROZIN et al., 2019; WAN, 2012). Furthermore, promoting trends using key-words or affective memory references on the label, such as "organic", "natural", "artisanal", "sustainable ingredients", "recycled packaging", "homemade", "made with love" and many others, is not enough. A real structural change is needed. Furthermore, recycling can be a good strategy for reducing wastage production; nonetheless, it also can result in more hazardous chemicals present in food packaging materials (JEDDI et al., 2022), which can be harmful to health maintenance. The customer expects better transparency regarding product composition and history, and this entails responsibility about the company's supplier choices (such as supplier quality in terms of product and company values), product carbon footprint and greater customer

[8] It is important to highlight that short chain or local producing not necessarily is synonymous of organic production. Organic means absence or less usage of harmful pesticides, fertilizers, irradiation and synthetic components (ASHAOLU and ASHAOLU, 2020) which can be or not local.

communication (FAO, 2022), which include food labeling. Labelling plays an essential role in choosing food and may even guide healthier food choices (MHURCHU et al., 2018; RUGGERI et al., 2019). Indeed, one ongoing industry's challenge is to correctly communicate with their consumer about the benefits of its products, clearly and transparently (SILVA et al., 2018). Currently, customers do not understand the labels (WAN, 2012), so the simplifying of food labeling is also needed (FAO, 2022); nevertheless, this is dependent on the authorities.

Also, the food industry should use trends beneficially to develop even more diverse foods, such as vegetarian/vegan, halal and kosher products, among others. Corrin and Papadopoulos (2017) related that people who follow a diet without meat or any animal origin product have difficulty finding convenience products (AMORIM et al., 2022b). Moreover, there is an estimation that people who live according to Islam will represent around 30% of the world population in 2050 (AMORIM e al., 2022b; JIA and CHAOZHI; 2021). For Muslims, food has a moral and spiritual importance, so if it is not prepared according to their religious rules, food must be rejected (AMORIM et al., 2022b; KOHILAVANI et al., 2021).

The global population is expected to pass 9 billion in 2050 (KNORR and AUGUSTIN, 2021). To meet the increasing demand for food and the variety of customer claims, overall food production will need to be raised by about 70 percent above 2009 levels, by 2050 (FAO, 2022). There is a big and complex market to be served and, and to meet this challenge, the FSC needs to adapt itself to the new trends. Finally, to feed all populations, it is necessary to preserve the environment. FSC aims to produce, transform and deliver food; however, without water, energy, raw materials, etc., how will healthy food consumption be possible? Environment preservation is not only beneficial to the private sector but is also one condition to its permanence.

2.10. Final remarks

Food safety and security improvements proportionated by food industry was reviewed. It is evident that thanks to the food industry and globalized world, unfavorable geographical places can, or should be able to, access a huge diversity of foods that before were not possible. Food processing at industry, in a large scale, safer and easier to be transportable is also as a tool to improve food safety and food security. However, this change has affected human feelings and, as a consequence, many customer claims, campaigns against the food industry and mistaken concepts, even within the academic

arena such as done with NOVA classification, have emerged. Nevertheless, NOVA classification was discussed and some mistakes were pointed out and clarified.

It is also evident that more dialogue, interaction and synergy among the various public food managers is necessary. The food system, despite promoting important civil and humanity improvements, is not perfect and several changes are needed, starting with transparency and sustainable choices. Food scholars and policymakers should work together towards the same goal: To promote health and quality of life to the population through food, and for this to happen, more dialogue and more union among the food fields are necessary, a start with the review of the food classification present on the Brazilian FBDG.

Food represents more than an important element to preserve human physiological activity. To some folks, food nourishes our body and our soul. In this context, food can represent who we are in terms of moral values and lifestyle. The food industry and the modern food system impact the way that customers consume and feel about its food consumption. Less than 200 years ago, food was cultivated, cooked and stored (in animal fat or salted) by families in a rural property without technology and scientific sanitary procedures. Today, we can buy food in a supermarket, restaurant, food service and many other places, ready or almost ready-to-eat. This cannot be forgotten in all discussions.

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CHAPTER 3

Hunger, obesity, public policies and food-based dietary guidelines (FBDG): a reflection considering the socio-environmental world context

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Published in Frontiers in Nutrition, v. 8, 805569, 2022.

3.1. Abstract

Nowadays, the world has been characterized by hunger, obesity, and food loss and waste. With the COVID-19 pandemic the food issue became more intense, serious and evident. Hunger demands urgent actions. Obesity levels have been raised and are removing health and quality of life from the population. Production planting practices and the food-supply chain are not necessarily ecologically friendly. Sustainability issues greatly intensify social problems. As well as food loss, waste and sustainability concerns, obesity and malnutrition are enhanced due to the lack of knowledge by the population. Processed food, packaging, and additives, despite still needing improvement, are essential to food security control. Nowadays, hunger is not due to insufficient agriculture practices, but rather to inequality and absence of adequate public policies. In a context of a certain abundance of food production and processing, the hunger scenario in contrast to food loss and waste is an ethical, social, moral and sustainable issue. In this context, a Food-Based Dietary Guideline (FBDG) can be an important public policy tool from health, nutrition, environmental and educational points of view. Despite the effort, the literature shows FBDGs can be better used to fulfil healthiness and sustainability purposes. In this scenario, elaboration/revision of the FBDG, adopting a clearer, simpler and a better suited communication strategy is essential. In this way, this article aims to discuss the importance of the FBDG as a public policy tool, not only regarding health issues but also communication strategies, production sustainability and humanitarian ones, which are crucial to FBDG´s efficiency.

Keywords: ultra-processed foods, processed foods, sustainability, food waste, food loss, food classifications

3.2. Introduction

Past centuries were marked by huge population losses resulting from hunger (CONTRERAS and VERTHEIN, 2019; HARARI, 2018). Nowadays, hunger still exists. According to “The State of Security and Nutrition in the World” report, published by FAO, IFAD, UNICEF, WFP and WHO (2021), around 650 million people suffered from hunger in 2019, representing an increase of 43 million people compared to 2014 and, as a result of the COVID 19 pandemic, it is estimated that around 118 million more people were faced hunger in 2020 than in 2019. By now, this estimation has not been confirmed

yet or recalculated. Globally, 149 million children under the age of 5 years were stunted and 45 million wasted in 2020 (WHO, 2021a). Despite the global agreement to eradicate hunger by 2030, the world is off the path to achieve it (FAO, IFAD, UNICEF, WFP and WHO, 2021).

At the same time, a greater number of people died as a result of non-communicable disease (obesity, diabetes type 2, cancer, among others) (LUCAS and HORTON, 2019; SILVA, 2019; WILLETT et al., 2019; ARES et al., 2021) and malnutrition (undernutrition – dietary energy deficiency, micronutrient deficiencies, overweight and obesity – dietary energy surplus) (HLPE REPORT 12, 2017; SWINBURN et al., 2019; WILLETT et al. 2019). Non-communicable disease and malnutrition are considered consequences of an unhealthy and unbalanced diet that can include high consumption of processed food.

In 2016, 39% adults worldwide – which represents 1,9 billion people – were overweight, being that 13% people were obese (WHO, 2021). According to WHO (2021), in 2020, 39 million children by 5 years-old were overweight or obese. Between the ages 5 - 19, the number was around 340 million in 2016. By 2020, it was predicted that a half of the world's population would be overweight (HARARI, 2018). Since 1975, worldwide obesity has nearly tripled (WHO, 2021). Until now, there is no updated obesity statistic from the WHO, considering the COVID 19 pandemic. The readers interested in studying on malnutrition and other diseases issues are invited to consult HLPE report 12 (2017), Willett et al. (2019) and Swinburn et al. (2019).

According to WHO (2021), obesity is preventable. Obesity is the excessive fat accumulation on the body, measured by Body Mass Index (BMI), which relates the weight by the square of its height in meters. Values greater than 25 kg/m^2 indicate overweight and, over 30 kg/m^2, obesity (WHO, 2021). The World Health Organization (2021) explains obesity as a result of energy imbalance between consumed and expended calories. This imbalance occurs mainly because of the inadequate food consumption - quality, quantity and frequency - and the sedentary lifestyle - absence of efficient physical activity (ROCKSTROM et al., 2016; WHO, 2021; van't ERVE et al., 2017). To change this reality, investments in public policies relating to health, agricultural, urban planning, transport, food processing, marketing and education are essential (WHO, 2021; HADDAD et al, 2016; TUOMISTO, 2018).

The balance between a healthy diet and efficient physical activity is the key point to reduce obesity (WHO, 2021). Nonetheless, Carretero et al. (2020) explained that diet is not a product. Diet is the amount of nutrients provided to the body. Each person has individual calories needs according to lifestyle (WHO, 2021, CARRETERO et al., 2020). Salt, sugar and fat intakes have to be restrained; however, their consumption also contributes to improving health. Soluble vitamins transport and absorption are dependent on the fat on the intestine (STEVENS, 2021). In addition, adequate oil intake can affect the reproductive feminine system (WATHES and CHENG, 2018).

To avoid obesity, the WHO advise people (WHO, 2021) to limit energy intake from total fats and sugars; increase consumption of fruit and vegetables, as well as legumes, whole grains and nuts; and engage in regular physical activity (60 minutes a day for children and 150 minutes spread through the week for adults). Moreover, it advises the food industry for reducing the fat, sugar and salt content of processed foods, ensuring that healthy and nutritious choices are available and affordable to all consumers, restricting marketing of foods rich in sugars, salt and fats, especially those foods aimed at children and teenagers, and ensuring the availability of healthy food choices and supporting regular physical activity practices in the workplace.

In the modern and globalized world, inefficient and imbalanced diets result in millions of deaths (WHO, 2021; LUCAS and HORTON, 2019; SILVA, 2019; WILLETT et al., 2019; HADDAD et al., 2016). Although hunger and obesity must be combated with equal intensity, according to Contreras and Verthein (2019), hunger is immoral and more aggressive to health than obesity. According to Sen (1981), the food security problem is not only related to food supply chain or food availability but rather to the entitlement, as a consequence of lacky employment and absence of good conditions of salary, which are more intense in underdevelopment countries.

The dramatic worsening in world hunger represents a violation of human rights (BACHELET, 2021). Urgent action and transformation in food systems are needed to ensure food and nutrition security. Public policies aimed to eliminate hunger and poverty are important since food insecurity is the result of political and economic choices. According to FAO, IFAD, UNICEF, WFP and WHO (2021), there are some important pathways towards food systems transformation to address major drivers of food insecurity, malnutrition and unaffordability of health diets. These pathways are related to: humanitarian and peace building policies in conflict-affected areas; scaling up climate

resilience across resilience food systems; strengthening resilience of most vulnerable to economic adversity; intervening along the food supply chains to lower the cost of nutritious foods; tackling poverty and structural inequalities; and strengthening food environments and changing consumer behavior to promote dietary patterns with positive impacts on human health and the environment. Nevertheless, gender inequalities, for instance, must be also considered as cause and outcome of unsustainable food systems and unequal food access, consumption, and production (NJULI et al., 2021).

Since the Industrial and Green Revolutions, there has been an abundance of food production, however, it was not enough to guarantee food security, despite the food industrialization. During the 20st century, according to Aguilera (2006), the food industry has shown consistent improvement as a consequence of technology advancements that allowed moving from batch to continuous processing, resulting in the production of thousands of units per hour of microbiologically safe and nutritious food. In addition to food production rising, the food industry development also reduced waste and energy consumption.

The food system inequality and contradiction are a reflection of the lack of public policies and rulers' omission (LUCAS and HORTON, 2019; SILVA, 2019; CONTRERAS and VERTHEIN, 2019). Food is at the core of human health. Having no knowledge or having misinformation about food results in public policy issues (FLOROS et al., 2010). The State has a duty to promote society's knowledge, especially when it implies safety and health (SILVA, 2019; HARARI, 2016). Farmers, Food Engineering, Technologists and Scientists, Nutritionists and Communication professionals can also contribute to humanitarian issues (LAZARIDES, 2012). The modern world challenge is, amidst waves of irrelevant information, to promote knowledge and equity to a more demanding and in-need population (HARARI, 2018). Thus, clarity is power (HARARI, 2018).

Therefore, this review aims to critically discuss the importance of Food-Based Dietary Guidelines (FBDG) as a public policy tool, not only considering health issues but also considering food production sustainability, humanitarian questions, and communication strategies, which are crucial to FBDG´s efficiency.

3.3. Methodology

All the FBDGs presented in this manuscript were consulted on the FAO website (FAO, 2021b), in which are available the link of the original dietary guidelines and the summary with the main information about the document content – such as official name, publication year, stakeholders' involvement, development process, implementation, evaluation, sustainability and recommendations – for each country. The FBDGs written in English, Spanish or Italian were read by the authors based on the original document and the documents written in other languages (French, Arabians, etc), were based on the FAO summary website.

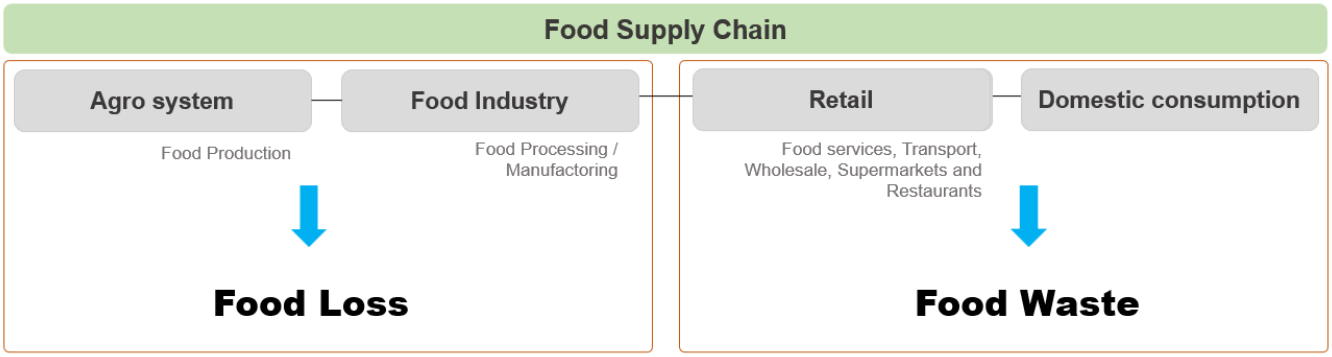
The focus was identifying the strategies adopted on the FBDG construction, especially the ones respected to communication, food classification system, recommendations and sustainability issues. The nutritional and sustainability analysis were based on the review articles and critical manuscripts developed by the experts in these areas, available on the main research platforms and newspapers, such as Web of Science, Science Direct, Pubmed, The Lancet Commission, etc.

In addition, the countries selection was made with a goal to discuss all the world regions and different cultures (America, Africa, Europe, Asia, Oceania and Arabian) to compare the strategies, social and sustainability concerns, besides the nutritional one.

3.4. Food Supply Management in the modern world

Food loss and waste (FLW) are concepts used to describe losses during the food supply chain management (OLIVEIRA et al., 2021; TEUBER and JENSEN, 2020; MORAES et al., 2021). Nevertheless, there are divergent definitions about food loss (FL) and food waste (FW) (TEUBER and JENSEN, 2020). In this article, according to FAO (2021a), food loss will be used to mean losses during the food production and/or processing while food waste will be used to mean losses during the retail and domestic consumption. In other words, food loss refers to losses pre, during and post-harvest and processing and food waste refers to losses of food destined to human consumption (Figure 1) (MORAES et al., 2021; OLIVEIRA et al., 2021).

Figure 1. Definition of food loss (FL) and food waste (FW) in the food supply chain.



Source: TEUBER and JENSEN (2020) adapted.

In addition to intensifying the clear contradiction between food production and hunger, reducing food loss and waste is an urgent necessity to improve sustainability (FAO, 2021a; TEUBER and JENSEN, 2020). Food loss and waste imply in the misuse of the world' limited energy. It represents an inefficient use of natural resources (especially water and land) and a useless greenhouse gas emission (MORAES et al., 2021), representing an evitable and unnecessary environmental impact (WILLIAMS et al., 2012). The world is going to have around 9 billion people in the near future (KNORR and AUGUSTIN, 2021), thus, to feed this population, natural resources must be preserved.

Furthermore, adequate food is a universal, constitutional and multidimensional human right advocated by the United Nations (FAO, 1990). Into sustainability dimension, this right is part of the duty to guarantee quality food access in sufficient quantities in the long term. Presently, at least 31% of the world's food production was lost or wasted, meaning that, around 1.3 billion ton of food has been wasted (FLANAGAN and PRIYADARSHINI, 2021; CONTRERAS and VERTHEIN, 2019; OLIVEIRA et al., 2021; SHARMA et al., 2021; BRENNAN et al., 2021). According to Sharma et al. (2021), the food loss and waste represent 1.4 billion hectares of fertile land, which encompasses 28% of the world agricultural area, 3.3 billion ton of CO_2 equivalents and USD 936 billion undermanaged. Reducing food loss and waste can represent USD 1 trillion in terms of economy (MORAES et al., 2021).

Food loss and waste occurs during all the food supply chain, from harvesting to home consumption (FLANAGAN and PRIYADARSHINI, 2021; CONTRERAS and VERTHEIN, 2019, SHARMA et al., 2021). Between 25-40% of the vegetable production

is lost in reason of the hygienic-sanitary conditions or because of a lack of standardization of quality criteria (size, color, texture, shape, appearance, etc.) or even, due to the absence of an efficient cold-chain (CONTRERAS and VERTHEIN, 2019). Moreover, 45% of the fruit and vegetables produced worldwide are not consumed which corresponds to USD 2.6 trillion literally thrown in the trash, if social and economic aspects are considered (SHARMA et al., 2021). To reduce this impact pesticides and synthetic fertilizers allowed by the Food Administrations and Agencies of each country are usually used. However, this method of reducing food loss can imply in chemical contaminations harmful to the environment and to customer's health (CONTRERAS and VERTHEIN, 2019).

On the other hand, according to Flanagan and Priyadarshini (2021), 30% of the food waste occurs during the home consumption and 10% in the retail segment. Between 40-60% of all household´s waste is food waste, and 2/3 of the food waste in Europe is avoidable. Furthermore, Flanagan and Priyadarshini (2021) estimated that 50% of the human food production is wasted. Between 3-10% of the food waste can result from inappropriate storing conditions besides labelling and shelf-life misunderstandings.

The population do not necessarily have knowledge about sustainability issues, food loss and waste and which kind of action they must take to reduce food waste. For example, according to WILLIAMS et al. (2012), UK consumers are more concerned about the discarding of the packaging than food waste, because they associate discarded packaging with environmental issues. Nevertheless, food waste provokes huge environmental problems in underdeveloped countries. Moreover, there is a contradiction between sustainability discourse and consumption practices (BARBOSA and VELOSO, 2014). In Brazil, routine habits such as eating, cooking, cleaning and personal care are not sustainable (BARBOSA and VELOSO, 2014) and it includes food waste resulting from exaggerated foodstuffs purchase (BRENNAN et al., 2021). Some cultures – such as North-American and Brazilian – understand abundance as social growth and it directly implies (un)sustainable consequences (BARBOSA and VELOSO, 2014; GASPAR et al., 2020). Moreover, domestic and routine habits are cultural and unconscious habits that follow moral and belonging rules (BARBOSA and VELOSO, 2014).

The packaging system as well as industrialized food are criticized because of sustainability issues. It is true that some packaging and food production systems are not ecologically friendly yet (such as meat production and non-biodegradable polymers). Moreover, there are chemical components applied in food production and food processes

that can be harmful for the health (AWORH, 2020; CONTRERAS and VERTHEIN, 2019). However, most of the additives applied in the food industry are healthy and from natural sources (GOMES et al., 2020; CAROCHO, et al., 2015, 2017). These additives are an important element to raise shelf life and, consequently, reduces food waste and hunger (GOMES et al., 2020). As well as packaging, additives can be considered as more beneficial than damaging to the planet. In addition, scientists around the world are doing their duty to improve industry sustainability and develop a sustainable food supply system, such as emerging technology, circular economy, bioeconomy and environmentally friendly packaging, among other approaches.

In a context of the certain abundance of food production and processing, the hunger scenario in contrast to food loss and waste is an ethical, social, moral and a sustainability issue (BRENNAN et al., 2021; FLANAGAN and PRIYADARSHINI, 2021). Unlike the past centuries, hunger is not due to insufficient planting, but rather to inequality and absence of adequate public policies (LUCAS and HORTON, 2019, SILVA, 2019; CONTRERAS and VERTHEIN, 2019), and food loss and waste is even part of the Sustainable Development Goals (SDGs) of the United Nations (UN, 2021a; OLIVEIRA et al., 2021). Moraes et al. (2021) described that government authorities have the role to advocate at all levels to implement sustainable programs. In this way, the FBDG can be a powerful tool.

3.5. Food Classification System

Currently, to improve health as well as to reduce non-communicable diseases and malnutrition, more than a hundred countries worldwide developed Food Based Dietary Guidelines (FBDG) to orient their population in their food choices and healthy lifestyle. By classifying food and guiding people about the quantity and frequency of food intake, the FBDG also contributes to Sustainable Development Goals (SDGs) achievements (RITCHIE et al., 2018; SPRINGMANN et al., 2020). Indirectly, the FBDG recommendations can influence the amount of CO_2 emitted during the food production (TUOMISTO, 2018; RITCHIE et al., 2018; AHMED et al., 2019). Nonetheless, according to Ritchie et al. (2018), the food intake and food classification recommendations are not clear. Therefore, to achieve SDGs success, a FBDG review is essential.

FBDG is a public policy tool used by rulers - especially health authorities - to communicate and educate their population about food choices. The Italian FBDG highlights that this document must consider the environmental characterization, in the other words, the FBDG must be appropriated to the economic, geopolitical, physical (availability) and sociocultural context (ROSSI et al., 2018). In this way, a multidisciplinary committee composed of technicians and scientists must elaborate the FBDG. Generally, health scientists (mainly nutritionists and medical doctors) elaborated food classifications (FAO, 2021b).

Most of the FBDG used food classification by their nutritional composition (Table 1). The North-American FBDG classified food as vegetable, fruit, grains, proteins and dairy (USDA, 2015). The Spanish one, in turn, classified food as wholegrain cereals and products, fruits, vegetables, olive oil, dairy products, fish, poultry, pulses, nuts, potatoes, eggs, red meat and meat products, sweets, snacks and sweetened beverages (MINISTRY OF HEALTH OF SPAIN, 2008). On the other hand, the Brazilian FBDG classified food according to what the authors considered as being food-processing levels (MINISTRY OF HEALTH OF BRAZIL, 2015). Moreover, in turn, the Uruguayan FBDG classified foods by their nutritional composition (vegetables and legumes; fruits; breads, flour, pasta, rice and potatoes; milk and cheese; meat, fish and eggs; seeds and oils; and sugars and sweets) and, inside these groups, distinguished them by their processing level (MINISTRY OF SOCIAL IMPROVEMENT OF URUGUAY, 2016) (Table 1).

Currently, at least seven food system classifications by processing level are known (Table 2). According to the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (TALENS et al., 2020), they are useful as complementary epidemiologic studies, such as the prevalence of obesity in specific geographical areas according to specific population groups – child, indigenous, breastfeeding, for example – in economic disadvantaged sectors. Talens et al. (2020) explain that each one of those classification has his own definition of process and the classification coverage can be local (IFIC, UNC, NIPH, IFPRI) or global (NOVA, SIGA). In addition, the readers interested in understand more about these food classifications, are invited to consult Talens et al. (2020).

Table 1 – FBDG communication strategies relating to food classification.

Country	Is the communication strategy graphic-visual?	Is the food classification system according to	
		Nutritional composition?	Processing level?
Spain	•	•	
Italy		•	
France	•	•	
Portugal	•	•	
Uk	•	•	
USA	•	•	
Canada	•	•	
Brazil			•
Argentina	•	•	
Chile	•	•	
Uruguay	•	•	•
Ecuador	•	•	
South Africa	•	•	
Australia	•	•	
United Arab Emirates	•	•	
India	•	•	
China	•	•	
Japan	•	•	

Sources: FAO (2021b).

Table 2 – Food system classifications according to processing level.

Name	Location	Classification system
IARC-EPIC	Europe	1- No processed food 2- Minimally Processed Food (industrialized or housewifely) 3- Industrialized food
IFIC	EUA	1- Minimally Processed Food 2- Processed food by simple conservation 3- Processed food 4- Convenience food 5- Packaged food
UNC	EUA	1- No processed or Minimally Processed Food 2- Processed food – simple level 3- Processed food – moderated level 4- Processed food – intense level
NIPH	Mexican	1- Modern industrialized food 2- Traditional industrialized food 3- Home processed food
IFPRI	Guatemala	1- No processed 2- Minimally or Partially Processed Food 3- Highly Processed food
NOVA	Brazil	1- No processed or Minimally Processed Food 2- Culinary ingredients 3- Processed food 4- Ultraprocessed food
SIGA	France	1- No processed or Minimally Processed Food (A_0, A_1 and A_2) 2- Processed food (B_1 and B_2) 3- Ultraprocessed food (C_1, C_2 and C_3)

Source: TALENS et al. (2020).

For being elaborated by health professionals, none of these classifications followed the definition of food processing as described by the Food Science, Technology and Engineering (FSTE) (PETRUS et al., 2021). Despite it being a processing level classification, most of this classification was defined according to the food ingredients (TALENS et al., 2020). Furthermore, only NOVA classification, whose description can be found in Moubarac et al. (2014) and Monteiro et al. (2019), was applied in a FBDG.

To the FSTE point of view, **minimally processed food** (MPF) is washed, sanitized, cut or chopped foods which are microbiologically safe and stable under convenient packaging system, which were not thermally treated (ALZAMORA, 2016), while **processed food** (PF) is a food product obtained by a sequence of unit operations (FLOROS et al., 2010; BOTELHO et al., 2018), usually different of these related to MPF and with an important energy footprint (PETRUS et al., 2021). Overall, MPF is important because it is practical to use and can reduce cooking time and reduce food waste at home,

as these foods have been cleaned, cut and seeds and husks eliminated in the industry. And PF is important mainly because it long shelf life, which means that consumer can eat these foods several days or even months after acquired. Nevertheless, overall, PF has also a negative appeal. However, benefits of foods processing must be recognized. For example, benefits of food processing by thermal treatments include inactivation of food-borne pathogens, natural toxins or other detrimental constituents, prolongation of shelf-life, improvement of digestibility and bioavailability of nutrients, improvement of palatability, taste, texture and flavor and enhancing functional properties, including augmented antioxidants and other defensive reactivity or increased antimicrobial effectiveness (van BOEKEL et al., 2010), besides contributing to decrease food loss and waste. More definitions of PF foods and unit operations for food processing can be found in Jones (2018), Floros et al. (2010) and Aguilera (2018).

Furthermore, recently, scientists from Sorbonne University (France) developed a nutritional system classification, called Nutri-Score (or 5C). Easy to understand, due to the adopted visual communication strategy, the Nutri-Score classification can be applied in food labelling (GALAN et al., 2019). Nutri-Score classified food in 5 groups (A, B, C, D and E) according to the food nutritional value, decreased from A to E (GALAN et al., 2019, 2021). The Nutri-Score classification system is used by the French and Spanish Health Ministry (GALAN et al., 2019; MANGER BOUGER, 2021). Botelho et al. (2018) reinforced that, to identify the real source of nutrients, it is indispensable to examine food group classification. Furthermore, besides the FBDG use, food classification is also a strategic tool for epidemiological studies and health treatments.

3.6. Food-Based Dietary Guideline Role

FBDG has been used as a tool to improve health and sustainability worldwide (FAO and WHO, 2019, 2021a; HERFORTH et al., 2019; RONG et al., 2021; van't ERVE et al., 2017; JONES, 2019; HESS et al, 2012). As a strategy to achieve the UN's 17 goals, the SDGs also include clear and correct communication about nutrients and diet (CARRETERO et al., 2020; UN, 2021a).

Proposing solutions to feeding issues is complex (CONTRERAS and GRACIA, 2012; FLOROS et al., 2010). It involves social, cultural, economic and moral issues besides requiring a technical multidisciplinary knowledge. Generally, health

professionals are involved in FBDG development (FAO, 2021b). These professionals are experts in understanding how the ingredients and their nutrients are metabolized by the human body, representing something beneficial or not to health according to their frequency and quantity intake. This analysis is important to FBDG success; nonetheless, it is not enough to achieve their purpose.

Besides the nutritional point of view, these guidelines should also consider the fact that the target population, and the society as whole, is made up by individuals who interact with each other. At most of the time, these same individuals respond to incentives and face trade-offs. Therefore, what is expected is that FBDG and/or policy makers have the knowledge of an optimal allocation of resources in the economy for consumers, producers and the food system.

It should be noted that consumer demand for food is an important element in the formulation of several agricultural and food policies. Changes in food prices and income are determinants of food demands. As Blundell (1988) stated for some policy issues, the importance of empirical evidence on consumer behavior is indisputable. Price and income demand elasticities for food inform policymakers and researchers about how consumers make food purchasing decisions and help the design of effective nutrition policies.

It is a recurrent empirical finding, in several countries and at different historical moments that the participation of food expenditures in the family budget decreases as their income rises. In fact, this is one of the most established empirical findings and regularities in economics and is known as “Engel’s law”, due to the studies by Engel (1895). The reference for the validity of “Engel’s law” is Houthakker (1957), but Chai and Moneta (2010) can be also consulted for a useful retrospective on Engel’s work. Moreover, Chattopadhyay et al. (2020) used Engel’s law to develop a mathematical model that can be applied as a tool for economic policy formulation. In addition, Lancaster (1966) proposed an alternative view on the consumer theory, that the goods are, in fact, a collection of characteristics. Sen (1985), in turns, includes the functionality attributed by the person to the goods on the Lancaster consumer theory: In Sen's terminology a "functioning" what an individual chooses to do or to be, in contrast to a commodity, which is an instrument which enables her to achieve different functioning. Sen (1985) states that it is not merely the achieved functioning that matter but the freedom that a person has in choosing from the set of feasible functioning, which is referred to as the person's "capability". This has become the so-called capability approach. This

approach has been immensely useful in the context of studying poverty, gender issues, political freedom, and the standard of living (BASU and LOPEZ-CALVA, 2011).

Engel's law has two broader implications for the structure of consumption expenditure (CLEMENTS and SI, 2017). First, there is a tendency to food specialization of the poorer's budgets in the sense that they are less diversified than those of more affluent consumers. Within the food budget, cheaper, more starchy foods (such as rice, potatoes and bread) are likely to be predominant for the poor, leading to less nutritious, less diversified diets (CLEMENTS and SI, 2017). The second implication of Engel's law is related to the quality of consumption. The declining food share that accompanies income growth means that the quality of consumption rises. Moreover, as food is the good consumed intensively by the poor, there is a natural link between Engel's law and the measurement of quality. Based on a study for more than 150 countries, Clements and Si (2017) found out some interesting relations between Engel's law, the variety of foods in the diet and their quality. While the food share falls with higher incomes, there is a tendency for spending to be more evenly over foodstuffs reflecting a more diverse diet.

Diet, economic-social matters and lifestyle are linked. Therefore, to achieve the FBDG's purpose, a multidisciplinary technical body is needed, and it includes social, economic and the human food chain professionals. The health professional knowledge is part of the human food chain (HFC). However, the HFC embraces soil handling, food production system, the complex and extensive food processing, filling and packaging, storage conditions at the sale point, and consumption. Thus, in addition to health professionals, the HFC must also be studied by Agronomists, Food Engineers among others. Efficient actions towards better health-standards applied in public policies demand interdisciplinary strategies, with public-private and academic support (FLOROS et al. 2010, CONTRERAS and GRACIA, 2012; HADDAD et al., 2016; LUCAS and HORTON, 2019).

Some countries used different strategies in their FBDG, in some cases, including the target audience, such as the general population, breastfeeding and children to the age 2, eldering, indigenous, etc. (RONG et al., 2021; MONTAGNESE et al., 2015, 2017; van't ERVE et al., 2017; HERFORTH et al., 2019). Generally, FBDGs encourage the consumption of water and a diversity of food in different proportions, always associated with regular physical activities (RONG et al., 2021; van't ERVE et al., 2017; HERFORTH et al., 2019). Ingredients such as sugar, fats and salt are shown as items to

be avoided or limited (FAO, 2021b; RONG et al., 2021; van't ERVE et al., 2017; HERFORTH et al., 2019). Among all the FBDG presented at Table 1, only those from Brazil and Canada do not recommend regular practice of physical activities. In June of 2021, the Brazilian Health Ministry released the "Physical Activity Guide for Brazilian Population" in a complement to FBDG. All FBDG can be found on the FAO website (FAO, 2021b).

French, Chilean and South African FBDG recommend consumption of food rich in starch daily, as a food base. According to Herforth et al. (2019), more than a half of the 90 FBDG analyzed in her review also encourage it. The UK FBDG, in turn, recommended several sources of carbohydrates as a food base, including breads and pasta. The South African FBDG was elaborated focusing on regional foods.

The Spanish FBDG - the healthiest country in the world, according to Bloomberg Global Health Index 2020 (WORLDHEALTH, 2021) - opted for a visual communication strategy, in which combinations of physical activities and food choice were suggested, specifying quantities and frequencies. To Portuguese, Argentinian and Chinese FBDG, healthy feeding should be complete, balanced, varied and followed by physical activity. The Italy - the second healthiest country in the world according to Bloomberg Global Health Index 2020 (WORLDHEALTH, 2021) - developed a technical FBDG explaining some "true or false" food issues, clearly and straightforwardly. Chile's FBDG, in turn, recommends reducing the television time and increasing the fast walking. USA's FBDG explains the energy intake should be appropriated by the personal needs. In addition, the North American FBDG highlights that the food choice must respect the individual preferences and cultural habits.

Italian, French, Argentinian, Australian, Chinese and Indian's FBDG, besides the reduction of salt, sugar and fat intake, also recommend limiting the consumption of alcohol. Brazilian, Canadian, Indian, Uruguayan, Ecuadorians and Australian FBDG extend this recommendation to processed food (Brazilian, Uruguayan and Ecuadorian FBDG - "ultra-processed" food and, Canadian and Australian FBDG - "highly processed" food), whereas British and Indian FBDG extend to tabaco. Indian FBDG recommends limiting processed food consumption, however, the distinction between industrialized food (processed food) and fast food (restaurants franchise) it is not clear. Ecuadorian FBDG, in turn, encouraged the reduction of processed food, fast food and sweetened

beverages, as the Brazilian one. Among all FBDG presented in Table 1, Japanese FBDG was the only one to orient their population to reduce food waste. This is remarkable!

The majority of the countries adopted the visual communication strategy, except Brazil and Italy (RONG et al., 2021; MONTAGNESE et al., 2017; van't ERVE et al., 2017; HERFORTH et al., 2019). Up to date, Italian visual communication has not been presented (FAO, 2021b). Canada, USA and France also use a website to communicate with the population. According to Hess et al. (2012), pyramid, plate among others visual communication strategies, do not change the FBDG efficiency and efficacy if the information is easy to understand and to follow.

To be effective, besides culturally accepted, the message must be clear, concise, practical, accessible and easy to be remembered (MONTAGNESE et al., 2015, 2017; HERFORTH et al., 2019; JONES, 2018). The United Arab Emirates FBDG used a tourist/architectural-cultural landmark of the country as a visual communication strategy, the "Burj Khalifa". This structure represents the feeding. The base of the structure is water. Each color represents a food group (cereals, vegetables, dairy, fruit, meat and fat) and its proportion represents the quantity/frequency of the consumption (FAO, 2021b). The Japanese FBDG applies a similar strategy (a popular toy).

There is a lack of data on the literature about the FBDG effectiveness. In the USA, according to Floros et al. (2010), the FBDG implementation prompted companies to change the product's formulation and to create foods that are more nutritious. Baked products and cereals now have higher fiber content and use whole grains. Convenience-store food made of fruit, vegetable and whole grains became available at the markets. The baby-carrot, not existent as of then, was widely accepted by the target audience. After reformulations, the trans-fat content was reduced in many products (FLOROS et al., 2010).

All the FBDG showed in the Table 1 classified food according to their nutritional composition, with exception of the Brazilian FBDG (TALENS et al., 2020). The Uruguayan FBDG classified food according to their nutritional composition and, inside each group indicated the processing level as well. In his strategy, the Brazilian FBDG classified food by their processing level based in the NOVA classification (MINISTRY OF HEALTH OF BRAZIL, 2015). Nonetheless, the main criterion on the NOVA classification is not necessarily linked to process as the action of processing food - using a sequence of unit operations - but according to the ingredients used in the formulation of

the food, in other words, the product or chemical component added before, during or post-processing.

In NOVA classification, stands out the term “ultra-processed” food, which was associated to products with low nutritional value (TALENS et al., 2020, KNORR e WATZKE, 2019; CARRETERO et al., 2020; ARES et al., 2016; GALAN et al., 2021). According to Monteiro et al. (2019), “ultra-processed” food would be industrial formulation with additive not used in domestic cooking (KNORR and WATZKE, 2019; ARES et al., 2016). Nevertheless, many Chefs are also using ingredients that are rarely used at home (GOMES et al., 2020), but they are not considered as being “ultra-processed” food producers. Indeed, it is not so easy to define UPF because it can be so heterogeneous in nutritional composition, as demonstrated by Lorenzoni et al. (2021), thus representing a heterogeneous group of foods with different characteristics.

Furthermore, according to Gibney (2019), there was no official definition to the “ultra-processed” term and the way that the author used it has changed over the years (TALENS et al., 2020; CARRETERO et al., 2020; KNORR and AUGUSTIN, 2021). Canada and Australia’s FBDG do not use this strategy and also recommend avoiding “high processed” products which are defined by them as products with high salt, sugar and fat content; different then the “ultra-processed” definition.

According to the Scientific Committee of the Spanish Agency for Food Safety and Nutrition (TALENS et al., 2020), there is no relation between health and type or intensity of processing level (SADLER et al., 2021; BOTELHO et al., 2018). Nutritional quality and (ultra)processing are distinct concepts that can affect health in different ways by their own mechanisms (GALAN et al., 2021). Nutritional value is related to the food formulation or composition (BOTELHO et al., 2018), regardless of whether it is made at home, restaurant or industry. Petrus et al. (2021), Carretero et al. (2020) and Knorr and Watzke (2019) related that the argumentative basis of NOVA classification is ingredients and not process parameters. Adding ingredients is part of the formulation (BOTELHO et al., 2018) and it is not related to process parameters. Process parameters arguments must involve temperature, pressure, time, amount or flow rate (for un- or continuous processes), and others, not ingredients. At home and in restaurants as well, homeworkers and Chefs also freeze, refrigerate, cook, ground, mould, dry, fry and apply other unit operations (AGUILERA, 2018). This made the Brazilian classification (NOVA) not

comprehensible, accessible, practical or viable (JONES, 2019; SADLER et al., 2021, CARRETERO et al., 2020, TALENS et al., 2020).

Knorr and Watzke (2019), Derbyshire (2019) and Petrus et al. (2021) considered the term "ultra-processed" more misleading than explanatory. Sadler et al. (2021), Carretero et al. (2020), Jones (2018) and Talens et al. (2020) reported that diets lacking "ultra-processed" food could also exceed the recommended amount of calories. In Brazil, salt and sugar intake is higher at food made at home than in industrialized ones (PETRUS et al., 2021). Ares et al. (2016) described that the term "ultra-processed" is not widely understood. Galan et al. (2021) showed that 21% of the ultra-processed food classified by NOVA have good nutritional quality. In addition, Petrus et al. (2021) remind that NOVA classification encourages raw or unprocessed food consumption, which cannot be safe and can increases foodborne disease. Therefore, the NOVA classification as well as "ultra-processed" term do not necessarily contribute to achieve healthy and the Sustainable Development Goals. Consequently, the Brazilian FBDG should be revised in terms of his food classification system adopted.

3.7. Future Challenges

Obesity is not an individual responsibility factor due to mistaken motivational choices (KLEINERT and HORTON, 2019; FLOROS et al., 2010). Obesity and malnutrition can also be related to sustainability issues (KLEINERT and HORTON, 2019; ROCKSTROM et al., 2016; WILLETT et al., 2019). The global warming consequences in food production will affect the underdeveloped countries more intensely, especially their economically disadvantaged part. According to Kleinert and Horton (2019), to solve malnutrition and obesity is necessary to implement sustainable business models with focus on health promotion. It is not only enough to produce quality food but also self-sustainable and accessible food to the population.

The COVID 19 pandemic has shown the current accessibility and production food system have not been efficient in protecting the population against hunger and obesity. In a social, economic and health crises scenario, we saw - at the same time - increasing hunger, obesity and food loss and waste (NESTLE, 2020). Not surprisingly, the 2020 Nobel Peace Prize was awarded to the UN's World Food Program. According to Berit

Reiss-Andersen, chair of the Norwegian Nobel Committee, food access cannot become a weapon of war and conflict (UN, 2021b)

The current global food system not only fails in fulfilling the basic nutritional needs but also intensifies pressure on the planet's sourcing boundaries (RITCHIE et al., 2018; TUOMISTO, 2018). According to Earth Overshoot Day (2021), a metric used to identify the point (in days) when humanity's demand for ecological resources exceeds what the Earth can regenerate at the same year, the Overshoot Day 2020 happened on August 22 and, in 2021, on July 29. The carbon footprint increased 6.6% from 2020. In other words, almost a half of the planet resource consumption in 2021 will not be recovered in the same year.

According to Springmann et al. (2020), the FBDG can also play a strong role in sustainability issues, which has not been adequately explored. FBDG, by guiding what and how much to eat, indirectly influences the amount of CO_2 generated during the food supply chain (TUOMISTO, 2018; RITCHIE et al., 2018; AHMED et al., 2019; SPRINGMANN et al., 2020). Nevertheless, Ritchie et al. (2018) report a lack of clarity in the recommendations.

In the future decades, the increasing population, urbanization and globalization will pressurize the world whereas natural sources will be increasingly scarce (HADDAD et al., 2016). Besides sustainability issues, it is worth noting one aspect regarding eating habits. In most western countries and based on women's increasing participation in the workforce, the food away from home (FAFH) is an increasing trend component of total food consumption and nutritional intake of adults and children. Empirical evidence shows that FAFH has been associated with poor diet quality (SAKSENA et al., 2018; TODD et al. 2010). Hence, policies designed to influence nutritional and healthy outcomes would be incomplete if they did not address the role of FAFH (OKRENT and ALSTON, 2012).

In relation to home production (unpaid domestic and care work), it is interesting to note that, mostly to women, home cooking declined in the late century and in the early years of the twenty first century (TAILLIE, 2018; HOLM et al., 2016; SMITH et al., 2013; AGUIAR and HURST, 2007). Historically, food preparation and household cooking have been assigned to women, and food at home (FAH) has been linked to female gender roles and identity.

Women have also had an important performance in the traditional food knowledge (TFK). The TFK refers to a cultural tradition of sharing food, recipes and cooking skills and techniques and passing down that collective wisdom through generations (KWIK, 2008). According to Kwik (2008) the value of this knowledge is hidden in a global food system offering an abundance of commercial convenience foods which is a consequence of urbanization and is intensified by a dynamic lifestyle (KNORR et al., 2018). In addition, in their study with children in Netherland, Folkvord et al. (2020) explain that food exposition as the cooking programs on television can influence eating behaviors. On the other side, according to Contreras and Ribas (2012), the "omnivore's deculturalization" is not related to food industrialization but rather to food medicalization.

Although men have increased their contribution to home cooking (HOLM et al., 2016), gender division of labor remains unequal, with women doing most of household chores. In most societies, women keep carrying the responsibility for labor of food provision - the most basic labor of care. Another interesting topic to point out is related to the elderly or the ones who retire. Based on what was noted by Becker (1965), that consumption is the output of a "home production" function that uses both expenditure and time as inputs. Aguiar and Hurst (2005) were the first ones to address the topic of meal preparation. They recognize that inputs of food production include not just food (modelled by food expenditures) but also the time spent shopping and preparing meals. They also showed that despite the sharp decline in food expenditures, neither the quantity nor the quality of food intake deteriorates with retirement status. Also, what they find is that these declining expenditures are offset by increased time spent shopping and preparing meals, suggesting that time and money are substitutes in food production. Nevertheless, these practices are not necessarily defined only by prices/expenditure (some monetary measure) and time. Then, better FBDG outcomes would require other considerations, which are multiple (nutritional, environmental, social and also economic among others) and varied.

Thereby, while the food production system does not pay attention to environmental, nutritional, social and economic issues, no other measure will be efficient (TUOMISTO, 2018). The food production system begins in cultivation technique, passing through processing food, filling, distribution to the market and storage to provide effects on the human body. Despite an unquestionable technological development, while

ensuring the scale production of microbiologically safe, nutritious, and appealing foods, the industry must also engage consumers and its stakeholders as well (SILVA et al., 2018).

The food production chain will be sustainable to the planet and to the individuals only when the public-private partnership and academia are strongly established (Agronomic Engineering, Food Engineering, Health and Public Policies) starting with a clear and educational FBDG elaboration. In addition, food industry must increase its transparency. A critical review on the abovementioned issues is essential for achieving the SDGs.

3.8. Conclusion

Malnutrition and obesity are consequences of imbalance and inequality diet. Currently, with a certain abundance of food as a consequence of the food production and the food industry, the accessibility of food quality and balanced food consumption emerged as a new concern, both intensified by the absence of the population knowledge. In the contemporary world, malnutrition exists because of the inefficiency of public policies, social inequality, low purchasing power and poor industrial-governmental agreements. Obesity is a preventable biopsychosocial and environmental pandemic, resulting from unhealthy lifestyle in a technological, sedentary and urbane system. In this contradiction, the under-management resources are evidenced by the not sustainable food supply chain practices, with high levels of food loss and waste, which result in overload of the planet and rising food insecurity. To aggravate this situation, the daily population habits are not sustainable, most of the time, made unconsciously and, in 2020, the world was affected by the COVID 19 pandemic that challenged the social, structural and ecological world system.

Because of this scenario already existent and serious even before the COVID 19 pandemic, governments worldwide developed FBDGs with a goal to orient and educate the population in their food choices and, in consequence, in sustainability issues as well. The FBDG should inform the population about the current problems and orient their decision-making in order to mitigate them. However, this important public policy tool can and should be better used from a health, nutrition, social and environmental point of view. Some FBDG, especially the Brazilian and the Uruguayan one, choose an incorrect

and misunderstood food system classification (NOVA classification) in terms of process definition. FBDG must be clear, correct and practical, otherwise, it will confuse the population and therefore lose its purpose and distort the economy.

With COVID 19 pandemic, hunger, malnutrition, obesity and food loss and waste have been intensified. Evidence shows we are not on the path to achieve the SDGs goals. Moreover, we are facing a dramatic transformation in our access to and the availability of food - along with where we eat and with who. Therefore, a radical change in the feeding system is urgent and necessary.

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GENERAL FINAL REMARKS

The Food-Based Dietary Guidelines were made worldwide to improve health and quality of life by food-intake and food choices. Nevertheless, the Food Science, Technology and Engineering professionals, who are responsible for food processing, were not included in this debate. This study expounds that this important public policy tool can and should be better used from a health, nutrition, social and environmental point of view. The FBDG should be clear, correct, easily put in practice, and respectful to lifestyles, otherwise, it will confuse the population, lose its purpose and distort the economy. As repeatedly noted in this Dissertation, the NOVA classification currently imbedded in the Brazilian FBDG does not match with these "best practice" requirements regarding food classification.

The recent campaigns against industrialized food, such as those made by the NOVA classification followers, have made a serious conceptual mistake about processing terminologies by ignoring that homemade foods are also processed, but not necessarily with sanitary rigorous controls as performed in industry by the FSTE professionals. Actually, the NOVA classification does not correctly consider food safety issues overall, and this can have a negative impact on public health policy. Furthermore, the NOVA classification also entirely overlooks social and economic matters provided by the FSC members that are crucial to food choices. Thanks to the FSC and globalized world, unfavorable geographical places can, or should be able to access foods that before were not possible; however, to achieve this effective public policies are also essential.

The anthropological analysis presented in this Dissertation clearly demonstrates that food intake not only involves physiological maintenance but also emotions and, generally, desires that are not always easily controlled. Food is culture, and despite the necessities of the technology perspectives, it is a subjective field, where it is not always possible to pass sentence as true or false, good or bad. It depends on the context that people are living in.

The food products developed by industry aimed to fulfill customer needs and expectations. Therefore, it is important to understand social anthropology aspects as well as technical matters, and this has not yet been properly addressed by the FSTE professionals and food industry. Historically, food systems and FTSE professionals, with

all their imperfections, have promoted important civil and humane improvements, especially regarding food security and safety issues, and now they are challenged to reinvent themselves considering current social drivers, which must include healthier ingredients in the formulation and ethical and sustainable procedures, and transparency.