TECHNICAL BRIEF

Understanding the Basics of Food Processing, Nutrition, and Safety and its Link to Plant-Based Meat

GFI Brazil

Credits

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International Cataloging in Publication Data – CIP

K182

Karatay, Graziele Grossi Bovi; Ambiel, Cristiana
Understanding the basics of food processing, nutrition, and safety and its link to plant-based meat: technical brief / Graziele Grossi Bovi Karatay and Cristiana Ambiel. – São Paulo: Tiibooks; The Good Food Institute Brasil, 2024.
E-BooK: PDF, 12 p.; IL; Color

ISBN 978-65-87080-87-1

1. Food. 2. Food Production Chain. 3. Food Technology. 4. Food Processing. 5. Nutritional Quality. 6. Food Safety. 7. Vegetable Protein. 8. Analogous Plant Foods. I. Title. II. Technical brief. III. Karatay, Graziele Grossi Bovi. IV. Ambiel, Cristiana.
V. IFC/Brasil.

CDU 664 **CDD 664**

Cataloging prepared by Regina Simão Paulino – CRB 6/1154

The Good Food Institute is a non-profit organization working globally to accelerate innovation in the alternative protein market. We believe that the transition to a more sustainable food system is fundamental to addressing the climate crisis, reducing the risk of zoonotic diseases, and feeding more people with fewer resources. Therefore, we collaborate with scientists, companies, investors, entrepreneurs, and government officials to develop plant-based, cultivated, or fermentation-derived food analogs.

Our work focuses on three main areas:

Corporate Engagement
We support companies of all sizes in developing, launching, and marketing alternative protein products, connect startups with investors, mentors, and partners, provide market intelligence to help companies make informed decisions, and conduct research to identify and overcome industry challenges.

Science and Technology
We fund cutting-edge research on alternative proteins, promote collaborations between scientists, companies, and governments, publish data and discoveries to drive scientific progress and design educational programs to train the next generation of alternative protein leaders.

Public Policy
We advocate for public policies that support the development and commercialization of alternative proteins, work with governments to create a favorable regulatory environment, educate the public about the benefits of alternative proteins, monitor the political landscape, and defend the interests of the sector.

With our work, we seek solutions to:

- **Feed nearly ten billion people safely, fairly, and sustainably by 2050;**
- **Contain climate change caused by the current food production system;**
- **Create a food production chain that does not rely on animals;**
- **Reduce the food sector's contribution to developing new infectious diseases, some with pandemic potential.**

In just over six years of operation in Brazil, GFI has already helped the country become one of the leading players in the global plant-based protein market. The intention is to continue developing this work to transform the future of food, promoting new sources of protein and offering alternatives analogous to those of animal origin.

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What is Food Processing, and why is it Needed?

Food processing is a practice that has been around for centuries and is crucial for transforming raw materials into the food and drink we consume. Whether on an industrial scale or in our kitchens, it can involve various processes like chopping, soaking, heating, and fermenting, among many others. The main reasons for food processing are to **(i) ensure food safety:** techniques like pasteurization, cleaning and sanitizing minimize contamination and the growth of harmful bacteria that could cause foodborne illness; **(ii) offer consumers convenient options:** pre-cut fruits and vegetables, ready-to-eat meals, and shelf-stable options provide nutrition for busy lifestyles, saving time in the kitchen and making diverse choices more accessible; **(iii) extend the shelf-life and stability of foods:** processing methods like canning, freezing, drying, and fermenting extend the shelf-life and stability of food by inhibiting microbial growth and enzymatic activity. This reduction in spoilage and waste can potentially increase food affordability and accessibility and **(iv) increase the choice and availability of foods:** processing allows wider distribution of food, making regional specialties and out-of-season produce more accessible, thereby increasing dietary diversity and contributing to a more global food system. All these reasons contribute to the critical role food processing plays in ensuring that our food is safe to eat, reducing food waste, and in the global challenge of feeding the world's growing population, estimated to reach 10 billion by 2050. Food processing is not a villain but an essential tool in contemporary life! While processing offers many opportunities for improving foods, it is crucial to recognize the **wide variation in processed foods' healthfulness as these depend on factors such as processing methods and the type and amount of ingredients used**. While processes like fermentation and pasteurization may offer benefits, others, such as removing nutrients like fiber, vitamins, and minerals, may reduce nutritional quality. Yet, fortifying and reformulating products can mitigate these possible drawbacks. In fact, **ingredient selection significantly impacts a product's nutritional quality, often more than processing**. While ingredients like refined sugars, sodium, and saturated fats can enhance flavor and texture, excessive use undermines the product´s nutritional value. Therefore, the key lies in **responsible food processing that balances the advantages of preservation and convenience with the maintenance and improvement of nutritional quality**.

How are Foods Categorized?

The Food Guide for the Brazilian Population (2nd edition - 2014) describes **four** food categories defined according to the level of processing. The **first category (NOVA 1)** includes fresh or minimally processed foods. Fresh foods, including fruits, vegetables, and eggs, are obtained directly from plants or animals. They arrive at consumers' tables mainly unchanged from their natural state. Minimally processed foods, on the other hand, have undergone few changes from their natural state, maintaining their nutritional value and taste. This can include washing and chopping fruits and vegetables, grinding grains into flour, pasteurizing milk, or refrigerating or freezing meats. The **second category (NOVA 2)** corresponds to products extracted from fresh foods or directly from nature and used by people to season and cook food and create culinary preparations, such as oils, fats, sugar, and salt. The **third category**

(NOVA 3) corresponds to products manufactured essentially with the addition of salt or sugar to a natural or minimally processed food, such as preserved vegetables, fruit in syrup, cheeses and bread. The **fourth category (NOVA 4)** corresponds to products whose manufacturing involves several processing steps and techniques and various refined ingredients, many of which are exclusively for industrial use. This category is the so-called ultra-processed foods, usually with few intact unprocessed or minimally processed foods. This category includes products with **diversified nutritional profiles**, such as potato chips, soft drinks, chicken nuggets, sausages, ham, milkshakes, fortified breakfast cereals, protein bars, plant-based milk and meat, each catering to different dietary needs and preferences.

Do All Ultra-processed Foods Have Poor Nutritional Quality?

Not necessarily! Even though that is valid for some ultra-processed foods, it is not the case for every product, as they are composed of different processing techniques and ingredient lists. Headlines often demonize ultra-processed foods, but the **reality is more nuanced**. While some are undoubtedly unhealthy, ultra-processed foods, including items like fortified cereals, flavored yogurt, and plant-based alternatives, can be part of a balanced diet. While many natural or minimally processed foods are nutritious, it's crucial to remember that the nutritional value of a food can vary greatly. For example, some meats are high in saturated fat and lack essential nutrients like fiber. The key is **understanding that the nutritional value of every food can vary significantly** and that there are differences between categories (e.g., cereal bars *versus* soft drinks), within categories (e.g., high-sugar *versus* low-sugar yogurt), and between brands of the same categories. For instance, a can of chickpeas and a pack of bacon are both classified as NOVA 3, yet their nutritional profiles are vastly different.

What is Plant-based Meat, and What are the Key Ingredients and Processing Steps?

Plant-based meat does not contain any animal products. It is made entirely from plants, and like animal-based meat, it is composed of protein, fat, vitamins, minerals, and water and aims to look, cook, and taste like conventional meat. Most plant-based options contain protein ingredients in flours, concentrates, isolates, and/or texturized vegetable protein forms (e.g., from soy, peas, chickpea, lentils, wheat, beans or mixtures). Other ingredients include fat (e.g., from soy, sunflower, cotton, corn, canola, palm, coconut), fiber (e.g., from soy, potato, wheat), and various additives such as flavorings, stabilizers, and colorings (e.g., from beetroot powder, Ponceau red, Caramel I). At the industrial level, the processes that make up each of these phases can be numerous and variable depending on the type of final product (e.g., whole cut, ground meat, burger). Yet, it generally comprises of **four** main phases:

1. Crop Development and Cultivation

Core to plant-based meat production is the careful selection and development of high-yielding, nutrient-rich crops, which involves **(i) identifying protein-rich plants:** researching and selecting plant species with high protein content, such as legumes, grains, and oilseeds; **(ii) breeding for desired traits:** developing crop varieties with optimal protein profiles, improved yields, disease resistance, and

adaptability to different growing conditions, and **(iii) genetic modification (optional):** utilizing biotechnology to enhance protein content, nutritional value, and other desirable characteristics.

2. Primary Ingredient Fractionation and Modification

The second phase involves extracting valuable ingredients from the developed crops. This process typically includes dehulling, grinding, wet or dry extraction, cold pressing, or other techniques to obtain proteins, flavors, aromas, colors, oils, or bioactive compounds. Fractionation separates the extracted mixture into distinct components based on properties like size, solubility, or chemical structure. Dry fractionation methods (e.g., sieving, air classification, electrostatic separation) avoid solvents, while wet fractionation uses solvents to isolate proteins, oils, carbohydrates, and fibers. These purified ingredients are supplied to product developers for final modification (optional) to meet specific plant-based meat product requirements. The desired properties include enhanced water solubility and improved functional characteristics such as emulsification, water and fat binding, gelation, and foaming.

3. Composite and Secondary Ingredient Processing (optional)

Primary ingredients can be further processed for **(i) texture creation:** Producing texturized proteins using low moisture extrusion for creating texturized vegetable protein (TVP) or high moisture extrusion for creating fibrous structures and **(ii) fat emulation:** Developing plant-based fat systems, such as oleogels, bigels, or emulsions, to replicate the mouthfeel of meat.

4. End Product Formulation and Manufacturing

The final stage involves combining all components to create a plant-based meat that not only mimics the taste and texture of traditional meat but also aligns with consumer preferences and culinary expectations. These include **(i) product formulation:** combining the processed ingredients in specific ratios to achieve the desired taste, texture, color, and nutritional profile; **(ii) mixing and processing:** blending the ingredients into a uniform mixture; **(iii) cooking and forming:** applying heat and pressure to shape the product into the desired form (e.g., patties, ground meat), and **(iv) cooling and packaging:** preparing the product for distribution by cooling and packaging.

By carefully controlling each process phase, manufacturers can create plant-based alternatives that resemble conventional meat products in taste, texture, and nutritional profile.

Is Plant-based Nutritious?

Plant-based meats vary widely in nutritional content, just like conventional meat products. To provide consumers, media, researchers and policymakers with accessible scientific information on the nutritional value of plant-based meat, GFI Brazil commissioned a study to evaluate the nutritional quality of plant-based meat sold in Brazil based on different quality indicators. The study[1] was conducted by Prof. Dr. Veridiana Vera de Rosso, a professor at the Federal University of São Paulo (UNIFESP) and coworkers. In summary, the study evaluated the nutritional quality of plant-based meat products available in Brazil. A total of 349 plant-based meat items were assessed, including burgers, meatballs, breaded meats, sausages, kibbeh, kaftas, mortadella, and bacon, among others. Different indicators were used to

[1] Locatelli, N.T., Chen, G. F. N., Batista, M.F., Furlan, J.M., Wagner, R., Bandoni, D.H., de Rosso, V.V. Nutrition Classification Schemes for Plant-Based Meat Analogues: Drivers to Assess Nutritional Quality and Identity Profile. Current Research in Food Science, p. 100796, 2024.

evaluate the nutritional quality of these products, including the Nutri-Score, the NOVA classification, and the LOUPE Nutritional Profile established by ANVISA's RDC 429/2020[2]. It was found that **80% of plant-based meat was classified as A, B, and C by Nutri-Score, 68% had good nutritional quality by the LOUPE, while NOVA classified 70% as ultra-processed.** The results demonstrate that many evaluated plant-based meat products met satisfactory nutritional standards regarding calories, protein, total fat, saturated fat, fiber, sodium, and additives. Moreover, the study findings challenge the assumption that all plant-based meat products are nutritionally inferior, revealing the limitations of using the 'ultra-processed' category (NOVA 4) as the sole indicator of nutritional quality in this context. Not all plant-based meat alternatives are created equal, and the added ingredients, level of processing and nutritional quality can vary depending on the product and brand. Therefore, there is no reason to villainize these products. It is essential to compare the nutritional value of plant-based meat to the kinds of foods it is designed to replace: conventional meat, not salads. In this comparison, research suggests that plant-based alternatives are lower in saturated fat and higher in fiber than their animal-based counterparts, which preliminary studies indicate may offer health benefits.

How Can Consumers Navigate the Multifaceted Nature of Food Processing to Make Informed Choices?

Responsible media and **transparent labeling** practices are crucial in guiding consumers toward making informed food choices. The media can help consumers make healthy and balanced dietary choices by disproving myths and highlighting responsible food processing practices. Consumers need clear information to understand that not all processed foods are nutritionally inferior. Notably, the term ultra-processed should not create confusion about the benefits of responsible food processing. What should be clear to the consumer is not whether or not the food is ultra-processed, but rather the **clarification that food high in salt, sugar, and saturated fats are the points that contribute to inferior nutritional quality.** This is the crucial point we should consider, and the same is true for food we cook at home! Therefore, it is paramount to educate consumers that the level of processing and number of ingredients does not define the nutritional quality of a product. **A food's processing level can only tell us how it was made; it cannot say anything inherently about its nutritional composition.** Nutritional composition, like calorie density and fat, salt, and sugar levels, are well established as significant determinants of food health. So, ignoring them and just looking at the processing level misses a substantial part of the picture. The ultimate measure of a product's quality is its ability to contribute to a balanced diet. This is determined by nutritional content and how it fits into overall consumption patterns. Consuming a balanced diet with appropriate nutrient intake is essential for overall health. **Consumers should use food labels to make informed choices that align with their nutritional needs.** While a salad is a healthy option, it alone cannot provide all the necessary nutrients. Therefore, understanding

[2] Karatay, G.G.B., Ambiel, C., Looking into the nutritional aspects of plant-based meat in the Brazilian market: technical brief. São Paulo: The Good Food Institute Brasil, 2024.

individual dietary requirements is crucial for creating diverse meal plans that deliver a comprehensive range of vitamins, minerals, and macronutrients.

What Are the Main Opportunities for Improving the Nutrition of Plant-based Meat?

There are numerous possibilities for producers to improve the healthiness of plant-based meat! Here are some possibilities:

Protein source: Ensuring a complete protein source with a full profile of essential amino acids. This can be achieved by selecting a single source like soy or combining complementary protein sources.

Fat source: Using healthier fats like avocado or sunflower oils instead of saturated fats like coconut or palm oil can significantly improve health benefits.

Fiber source: Prioritizing ingredients rich in dietary fiber, such as whole grains, vegetables, and legumes like vegetable flour, naturally high in complex carbohydrates and fiber.

Ingredient reductions: Minimizing added salt, saturated fats, and sugars can improve the overall nutritional profile.

Nutrient fortification: Adding essential vitamins and minerals lacking in certain plant-based ingredients, like Vitamin B12, iron, and zinc, can create a more nutritionally complete product.

Processing methods: Refining extraction techniques to isolate protein sources from plants while minimizing harsh chemicals or excessive heat treatment can create healthier and more bioavailable protein sources.

Transparency and labeling: Providing clear and detailed information about ingredients, processing methods, and nutrient content allows consumers to make informed choices about the healthiest plant-based meat options.

Focusing on these possibilities allows manufacturers to develop plant-based meat alternatives that are delicious, convenient, nutritious, and ideally suited for a healthy diet.

Is plant-based Meat Safe?

All foods can pose dangers to consumers, which is why food processing carried out by industries with qualified professionals is the best way to guarantee food safety. The risks in plant-based meat are the same as those in any food, including physical, chemical and biological. Plant-based meat is produced using Generally Recognized as Safe (GRAS) plant ingredients and undergoes stringent food safety regulations like any commercial food product. As they are new foods, it still takes time to create scientific evidence of potential dangers, that is, those that are most significant in these products. Therefore, while it's essential to remain vigilant about food safety, based on current regulations and practices, plant-based meat is produced under the same safety standards as any other food product, ensuring it is a safe food option. The GFI encourages investigations and discussions on the topic so that companies have increasingly more scientific input and can adopt preventive and control measures to guarantee safe food production. To learn more about food safety initiatives and resources, visit our website.

How Does Food Processing Impact our Connection to Food and its Environmental Footprint?

Just think about what you ate yesterday or today: did you buy vegetables, milk, eggs and fresh meat and make everything from scratch? Is our butter produced in-house? Our yogurt? Has our oil or olive oil been squeezed at home? Do we eat homemade bread made from wheat that we throw at home? Most people will answer a series of "no's" to these questions because the issue of industrialization of the food chain happened dozens of years ago, and today, food processing at industrial levels is already a reality. The fact that the plant-based category is also processed is due to the world's reality; this is the food chain today. Alternative proteins are a powerful candidate for maintaining our traditional diet, especially since the planet is showing increasingly clear signs that it cannot supply the natural resources needed to support conventional modes of food production. What we eat, how we get it, and how we prepare and consume it is not 100% delegated to an industry, as it is cultural. It carries our culture, beliefs, habits, family recipes, and demographic profiles. Even as production methods shift towards sustainability, people's desire for familiar flavors and traditions suggests a continued preference for recognizable ingredients and dishes. Yet, a lot must change, including the technology used to produce these foods people want. A sustainable future doesn't necessitate the elimination of meat, dairy, eggs, or seafood from our diets. Instead, it requires a transformative shift in food production to render these familiar flavors and traditions more efficient, sustainable, ethical, and nutritious. A flourishing wave of startups and companies are dedicated to achieving this goal by developing innovative plant-based alternatives to accommodate our desires.

“Food processing is crucial in ensuring food safety, convenience, and accessibility while contributing to the global challenge of feeding a growing population. However, the nutritional quality of processed foods can vary widely. Therefore, evaluating processed foods comprehensively is essential, considering their nutritional composition, processing methods, role in a balanced diet, and compatibility with individual dietary preferences.”

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