

Plant-Based Meat Alternatives

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Plant-based meat alternatives (PBMA) are highly processed products that aim to imitate the experience of eating meat by mimicking animal meat in its sensory characteristics such as taste, texture, or aesthetic appearance.

plant-based diet

plant-based meat alternatives

motivational barriers

1. Introduction

In order to arrive at a sustainable future, it is important to rethink existing consumption practices. Meat consumption is in particular challenging in this regard as it places a heavy burden on the environment ^{[1][2][3]}. Animal-based foods have a bigger ecological footprint than plant-based foods, emitting more greenhouse gas emissions, requiring more land and nitrogen, and impacting terrestrial and aquatic biodiversity ^[4]. Consequently, increasing the consumption of plant-based foods, e.g., by replacing meat with meat substitutes, is normatively desirable ^[5] as it can be considered a ‘win–win’ situation with respect to both health and environmental protection ^[4].

Plant-based meat alternatives (PBMA) are highly processed products which try to mimic the ‘meaty’ characteristics of animal meat products, for example the ‘bleeding’ of a burger patty ^[6]. According to Slade ^[7] (p. 428), “there is a culinary race to create a plant-based burger that is indistinguishable from beef”. The highly successful Beyond Burger even advertises with a “Now even meatier” claim ^[8]. In addition to plant-based burger patties, there are also PBMA that mimic mince, sausages, or chicken with their typical taste, texture, and physical appearance. PBMA are intended to replace the meat component in many dishes due to their similarities in form, taste, and preparation method. However, that also means that those meat substitutes are oftentimes directly compared to their ‘original’ counterpart meat ^[9].

While the market for meat substitutes is booming, a majority of consumers are often still not attracted to these products ^[10]. Even in Switzerland, one of the most progressive countries in the world, average meat consumption per capita (47.8 kg in 2019) is above the global average and willingness to eschew meat among Swiss consumers is low ^[11].

Accordingly, while more than half of the Swiss population have already tried plant-based products ^[12], the question arises: what keeps consumers from changing their diet for good.

2. Plant-Based Meat Alternatives: What We Know

2.1. Why People Decide to Ban Meat from Their Diets

There are oftentimes multiple reasons why consumers decide to (at least gradually) remove meat from their diet [9], ranging from animal protection, protection of environmental resources, or personal health and weight control [9][13][14][15][16]. One of the most prominent reasons to renounce meat intake and to adopt a plant-based diet is motivated by health concerns [13][15][17][18][19][20][21]. Medical research indicates that high levels of (especially red and processed) meat consumption can be linked with several diseases, including cancer [22][23] and cardiovascular diseases [24][25][26]. Likewise, especially in high and middle-income countries, the intake of red meat is showing a negative impact on life expectancy [27]. Against this background, Izmirli and Philips [28] found that a large majority of vegetarians stated health reasons as one of the main motivators to refrain from eating meat. This finding is corroborated by self-reports indicating that vegetarians engage more with health issues [29][30][31][32] and are more weight-conscious [31][32][33].

While health concerns might be the reason to adopt a new diet, a recent study found that animal welfare is the main motivation to continue the diet [15]. In particular, vegetarian and/or vegan consumers link the consumption of meat to animal cruelty [28][34][35][36].

Besides ethical reasons (i.e., animal welfare) the role of environmental concerns in the context of meat consumption is growing. While sustainability and environmental concerns in general have been around for many years, its impact on consumer decision-making in the context of meat consumption is yet to unfold. One reason lies in the lack of awareness of the negative impact associated with meat production and consumption [18][37][38][39]. Only in recent years has meat consumption become a moralized issue for a growing number of consumers [40]. There is now a general consensus that meat production is associated with heightened greenhouse gas emissions and biodiversity loss [2]. In fact, livestock farming is responsible for 14.5% of greenhouse gas emissions [41]—nearly a third of agriculture's water footprint [3]—and is a major driver of deforestation [42]. From a consumption perspective, high meat-eaters cause almost twice as many carbon dioxide emissions than vegetarians [43].

2.2. Plant-Based Meat Alternatives (PBMA)

The alternative protein market is growing rapidly [44]. Besides alternative animal-based protein sources such as edible insects or lab-grown meat (i.e., meat produced in the lab without raising and slaughtering the animal, also termed clean meat, cultured meat, in vitro meat, or artificial meat), non-meat protein sources are a promising alternative to traditional meat. The market for non-meat proteins is booming and there is a variety of different products available in the market (see **Figure 1**). Non-meat protein sources vary in the extent to which they are processed. Foods are considered 'natural' if they are free from human intervention, such as removing negatives or adding positives [45][46], and examples of natural non-meat proteins are algae, lentils, pulses, soybeans, or fungi. These proteins are also typical ingredients in vegetarian and vegan cuisine.



Figure 1. Overview of alternative protein sources.

Foods are considered ‘processed’ if they have gone through different production steps or if other ingredients have been added to create the final product. Due to their comparable texture to processed meat products, these products are often perceived and consumed as plant-based meat alternatives (PBMA, also referred to as meat substitutes or meat analogues). Some of them, for example, tofu and tempeh, have been consumed in Asia for centuries [47]. This ‘first generation’ of PBMA were mainly based on soy. While Asian consumers perceive soy as a traditional food in their diet, Western consumers often have a negative image of soy [48]. Moreover, consumers in many countries hold unjustified concerns about genetically modified foods, and soy is often among those foods of concern [49]. ‘Second generation’ PBMA use different ingredients, are more highly processed, and thus manage to improve the sensory experience. New technologies such as extrusion has facilitated the development of food products from extracted pea or oat protein, which create a meat-like structure [50][51]. As part of this second generation PBMA, ‘ready to eat’ PBMA have recently been entering a market that tries to imitate the meaty original and tends to be rather highly processed.

PBMA have the best chance of successfully replacing meat when they closely resemble highly processed meat products in taste and texture and are offered at competitive prices [52].

2.3. Barriers to PBMA Consumption

2.3.1. Structural Adoption Barriers

Several authors have examined barriers that hinder consumers from limiting or banning meat and switching to a plant-based diet (for recent reviews, see [5][11][13][53][52][50][51]). Some of these barriers are predominantly structural and are tied to the general demand of PBMA. For example, it may not always be convenient to purchase PBMA as they have limited availability in grocery stores or restaurants [15]. Another structural barrier is the relative newness of PBMA and a corresponding lack of exposure [9].

In summary, over time and with increasing consumer demand, the structural barriers will likely diminish and may even disappear entirely. According to self-reports, consumers would eat more plant-based foods if these structural barriers disappeared [15].

2.3.2. Motivational Adoption Barriers

Besides structural barriers, motivational barriers exist that will likely persist regardless of improvements in availability, exposure, and affordability. These motivational barriers are summarized as follows: (1) food neophobia, (2) social norms and rituals, and (3) conflicting eating goals. **Table 1** lists these barriers as well as exemplary research findings. The motivational barriers jointly contribute to prevailing meat attachment, a positive emotional bond people have with meat [54]. Overcoming meat attachment is a key challenge for increasing PBMA adoption.

Table 1. Motivational Barriers to PBMA Adoption.

Motivational Barrier	Research Findings
Food neophobia	<ul style="list-style-type: none">• A general reluctance to eat new foods hinders PBMA adoption [9]• There is a strong link between meat consumption and the celebration of important holidays (e.g., Thanksgiving or Christmas) [55][56]• Consumers find it difficult to avoid meat when most of their family and friends consume meat [55][56][57]
Social norms and rituals	<ul style="list-style-type: none">• People lack knowledge of how to eat in an alternative way [21][58][59]• Masculine-stereotyped dietary practice stands in the way of reduced meat consumption [60][61]• People have established routines of preparing and eating meat [62][63] but lack knowledge of how to prepare PBMA [64]
Conflicting eating goals	<p>Indulgence:</p> <ul style="list-style-type: none">• Lower sensory attractiveness of PBMA [9][16][64]• Hedonic enjoyment of eating meat [16][21][58][57][65] <p>Health:</p> <ul style="list-style-type: none">• Belief that animal meat contains important nutrients that cannot be substituted [21][65]• Perceived un-naturalness of ultra-processed PBMA [66][67][68]• Increase in undesirable nutrients such as saturated fat, sugar, and sodium [69]

References

3. Solutions to Increase Consumption of Plant-Based Meat Alternatives

1. Hoek, A.C.; Malekpour, S.; Raven, R.; Court, E.; Byrne, E. Towards environmentally sustainable food systems. Decision-making factors in sustainable food production and consumption. *Sustain. Prod. Consum.* 2021, 26, 610–626.

3.1. Solutions to Counter Food Neophobia

2. Godfray, H.C.J.; Aveyard, P.; Garnett, T.; Hall, J.W.; Key, T.J.; Lorimer, J.; Pierrehumbert, R.T.; Scarborough, P.; Springmann, M.; Jebb, S.A. Meat consumption, health, and the environment. *Science* 2018, 361, eam5324. It may be difficult to promote plant-based diets among consumers with high food neophobia, as neophobia is very difficult to transform [9]. Yet, one way to reduce neophobia is to make novel foods resemble familiar foods [70], which is the central idea behind PBMA. Against this background, the “Now even meatier” claim on the Beyond Burger can be seen as a good tactic to spark interest in PBMA. Product improvement is therefore seen as the most promising path to counter food neophobia, while providing information on environmental benefits is not likely to be effective in this regard [1–2, 25, 36].

4. Willett, W.; Rockström, J.; Loken, B.; Springmann, M.; Lang, T.; Vermeulen, S.; Garnett, T.; Hildner, D.; DeClerck, F.; Wood, A., et al. Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet* 2019, 393, 447–492. Beyond product improvement, marketers could try to spark curiosity or turn supposed disadvantages into strength. Labels can be used to highlight aspects of PBMA that grab consumers’ attention and make them reconsider their typical choices. For example, recent consumer research has shown that unattractive produce can be sold more effectively, if it contained “ugly” labels [71]. Notably, this is a different labeling strategy than the more common claims that focus on scientifically verifiable characteristics (e.g., “low fat” or “high vitamins”) of the food’s natural

5. Weinrich, R. Opportunities for the Adoption of Health-Based Sustainable Dietary Patterns: A Review on Consumer Research of Meat Substitutes. *Sustainability* 2019, 11, 4028. 6. Hu, Y.; Di, O.; “Be Good, Live Earth, Or Cope!” [45] This Plant-Based Meat Alternative Is Pastoral Healthy and Sustainable Diet? *JAMA* 2019, 322, 1547–1548. Such skepticism is partly due to consumers using different sources and types of knowledge to decode sustainability claims, in addition to the sheer number of 7. Slade, P. If you build it, will they eat it? Consumer preferences for plant-based and cultured meat burgers. *Appetite* 2018, 125, 428–437. A label that aligns with the visual assessment of the food (such as “ugly” labels) has a clear advantage in this regard. Using creative labels could therefore be a way to increase consumers’ willingness to try

8. Beyond Meat. Meat the New Meatier Beyond Burger with Marbling That Melts and Tenderizes Like Beef! Available online: <https://www.beyondmeat.com/whats-new/meat-the-new-meatier-beyond-burger-with-marbling-that-melts-and-tenderizes-like-beef> (accessed on 28 October 2021).

3.2. Solutions to Counter Social Norms and Rituals

9. Hoek, A.C.; Luning, P.A.; Weijzen, P.; Engels, W.; Kok, F.J.; de Graaf, C. Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance. *Appetite* 2011, 56, 662–673. Social norms are difficult to ignore, which effectively leaves two solutions to counter their inhibiting influence on a ‘meat-free’ diet. The first option would be to change these norms, but this is admittedly a process that takes time. However, younger generations are much more willing to eat plant-based and try novel foods [73][74]. In a recent

10. Gebhardt, B. Plant Based to the Future. In *Insights on European Consumer and Expert Opinions*; University of Hohenheim: Hohenheim, Germany, 2021. study, younger age was associated with increased willingness to try in vitro meat [75], which points to a slow shift in norms over time. In these situations, it is advisable to communicate what is called a trending norm and not the prevalent norm [76]. Instead of highlighting the current state of a behavior (i.e., X% of a reference group show the

11. Hartmann, C.; Siegrist, M. Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends Food Sci. Technol.* 2017, 61, 11–25. ‘static norm’), trending norms emphasize the increasingly changing norm over time to elicit (pre-) conformity to this change. Compared to static norms, the dynamic norm information that increasingly more people are beginning to

12. Coop. Plant Based Food Report Studie Zum Pflanzenbasierten Genuss in der Schweiz. 2021. Available online: <https://www.coop.ch/content/dam/coop-mediennetz/medienmitteilung/2021/pflanzenbasierte-ersatzprodukte-werden-immer-beliebter/Coop-Plant-Based-Food-Report-2021-DE.pdf> (accessed on 29 October 2021).

3.3. Solutions to Minimize the Influence of Conflicting Eating Goals

Supposedly, the biggest challenge to PBMA adoption is minimizing the inhibiting influence of conflicting eating goals. While continuation in the path towards increased mimicking of traditional meat could be useful in some areas, it may have detrimental effects in others. For example, PBMA products that closely resemble traditional

13. Fiebert, A.; Gazdecki, M.; Velez-Holmes, M.; Szakály, M.; Szakály, Z. A Comprehensive Review of the Benefits of and the Barrier to the Switch to a Plant-Based Diet. Sustainability 2020, 12, 4136. The more closely PBMA resemble meat dishes, the more obvious the highly processed state will become. Another strategic option is to emphasize both health and environmental benefits in all marketing communication attitudes towards human and animal welfare and moral behavior. Meat Sci. 2015, 99, 68–74.
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