Plant-based meat and health in Europe

A review of current evidence, key priorities, and frequently asked questions

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About this document

Diversifying Europe's protein supply is essential if governments are to address global challenges such as climate change, food insecurity, antimicrobial resistance and biodiversity loss. At the same time, diet-related ill health represents a growing burden on European economies and health systems. Increasing the proportion of plant-based foods in our diets is therefore a growing priority for governments – and plant-based meat has a key role to play in this transition.

While academics and policymakers are beginning to recognise the environmental advantages of plant-based meat, many still have questions about its nutritional benefits.

Here, we'll take a deep dive into plant-based meat and health in Europe, including recommendations for areas of future study and product development.

We would like to thank the following people for sharing their time, expertise, and thoughtful review during the drafting of this report:

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Please note, this document is not intended as medical advice, and individuals seeking information on their personal diet should consult with a qualified health professional.

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1 Introduction

Eating plants is good for you. Countless studies have repeatedly found that diets high in plant-based foods such as legumes, whole grains and vegetables have significant health benefits, reducing the risk of illness and death.[1,2,3]

The 2019 Global Burden of Disease study found that in European countries, under-consumption of various plant-based foods and over-consumption of red and processed meat and foods high in salt, sugar, and saturated fat were among the key drivers of diet-related illness and death.[4] Within this, however, little has been done to specifically explore where plant-based meat fits in this picture.

What is plant-based meat and why is it important?

Plant-based meat looks, cooks and tastes like conventional meat – but is made from plants or fungi. By reducing reliance on conventional animal agriculture, plant-based meat can help address a number of pressing global issues:

- **Climate change**. Plant-based meat is significantly more efficient than conventional meat, with greenhouse gas emissions reductions of as much as 80-90%.[5]
- **Food insecurity.** Plant-based meat has shorter supply chains and requires far fewer resources to produce, which means it could help make food supplies more resilient in the face of war, climate shocks and supply chain vulnerabilities.[6]
- **Biodiversity loss.** Modelling suggests that substituting 50% of global meat consumption with plant-based meat would effectively halt the destruction of forests and natural land.[7]
- **Antimicrobial resistance.** In Europe, over half of antibiotics used are fed to farmed animals,[8] driving resistance. Plant-based meat production is antibiotic-free, reducing pressure on these life-saving medicines.
- **Zoonotic diseases.** Intensive animal agriculture and the deforestation associated with meat production are two key drivers of emergent zoonotic diseases that could pose a threat to humans.[9] Both bird flu[10] and swine flu[11] are particularly concerning diseases currently circulating in European farmed animal populations.[12] Producing plant-based meat is therefore a way to satisfy growing demand for meat without driving this risk.

But is it healthy?

A healthy diet contains a wide variety of foods and plant-based meat can contribute to this.

From the outset, it is important to note that there is wide variation between available plant-based meat options and their nutritional attributes. Similarly, people's dietary needs can vary greatly, and people who are older, pregnant or athletes may need to pay special attention to certain nutrients. Given the breadth and complexity of this topic, this report's focus is on the macro scale, looking at averages across products in relation to general health guidelines from European public health bodies, rather than offering specific health advice.

In this context, compared to conventional meat, plant-based meat can meet many of the same nutritional needs while usually containing more fibre and less saturated fat. Processing techniques used to make plant-based meat can also enhance the prevalence and digestibility of the nutrients within it.[13,14]

Relative to the large body of evidence on the numerous benefits of plant-based whole foods such as whole grains, beans and vegetables, research into the impact of plant-based meat on health outcomes is still limited, but initial studies indicate substituting conventional meat for plant-based options could reduce the risk of heart disease,[15,16] improve gut health[17,18] and help maintain a healthy weight.[19]

Therefore, plant-based meat can offer consumers convenient options that are easy to incorporate into their diets as they transition towards more plant-based ways of eating, alongside existing initiatives to improve the availability and accessibility of plant-based whole foods.

In addition to benefits compared to red and processed meat which are associated with established risks, there are also important benefits of plant-based versions of other meats like chicken or fish. Conventional meat production is a key driver of several public health threats such as antimicrobial resistance, pandemic risk, air and water pollution, and climate change. In the case of fish, current production is unsustainable and yet cannot produce enough omega-3 to meet optimal global needs.[20] Conventional production of meat is also far more resource-intensive than plant-based production and is therefore more vulnerable to supply shocks and inflation.[21]

Climate change, animal pandemics such as bird flu and swine fever, and overfishing are already beginning to impact the cost and availability of conventional meat and seafood, and without diversification of the protein supply to reduce dependence on conventional production, this will

continue. To achieve that, government investment in research and development for healthy, delicious and affordable plant-based meat is crucial.

This report finds that plant-based meat could help people reduce their meat consumption to recommended levels without requiring major behaviour change, and while offering various other benefits.

Priorities and recommendations:

Based on the findings of this report, we recommend that **governments and funders** should prioritise investment in research and development to better understand and optimise the health potential of plant-based meat, with particular focus on the following areas:

- **Developing next-generation plant-based meat products**, to enable optimisation of nutrient bioavailability and taste, as well as improving functionality and broadening the range of available options, such as whole cuts, that fit easily in healthy, balanced meals.
- **Diversification of ingredient crops and expansion of breeding specifically for use in plant-based meat.** This will improve the functionality of raw ingredients, reducing the number of processing steps and additional ingredients needed. It will also enable further improvements in nutritional value and allow protein crops to be grown locally.
- **Developing novel processing technologies (including the use of fermentation)** which are better able to maintain or further boost the nutritional value of plant-based meat ingredients.
- **Conducting high-quality trials investigating the health impacts of swapping plant-based for conventional meat** to bolster the evidence base underpinning the important role of plant-based meat in public health.

We also recommend that **companies and the sector** more broadly focus on:

- **Better communicating the health benefits of their products to consumers** so consumers understand how to incorporate plant-based meat into a healthy, balanced diet.
- **Innovation** to further improve the nutritional quality of plant-based meat, through approaches such as micronutrient fortification and salt reduction.

Glossary

Diet and nutrition are complex topics. Below are some important terms and definitions used in this report.

ALA: Alpha-linolenic acid or ALA is a short-chain omega-3 fatty acid found commonly in plant oils and seeds.

Amino acid: Amino acids are molecules that form the building blocks of proteins. There are 20 different amino acids needed by the human body to grow and function. The body can make 11 of these itself, and nine must be consumed in food.

Anti-nutrients: A compound in food that interferes with the body's absorption of nutrients. Phytate is a common example found naturally in plants.

Bioavailability: The proportion of a nutrient in food that is absorbed and used by the body.

Caloric density: The number of calories in a food per 100g. High fat foods tend to have a particularly high caloric density.

Cardiovascular disease: A disease of the heart or circulatory system. This can include trouble with the heart itself such as heart failure or blood vessels in other parts of the body such as stroke.

Complete protein: A protein source containing all nine essential amino acids that are needed from dietary sources.

Confounding factors and correlation-causation fallacy: A common flaw in reasoning where it is assumed without sufficient evidence that two things happening at the same time had a causal relationship with one another. For example, studying rates of ice cream consumption and rates of sunburn, finding they mirror one another, and concluding that eating ice cream increases the risk of sunburn. In this example, it is obvious that eating ice cream and getting sunburn are probably both caused by an additional factor not being studied – as you are more likely to buy an ice cream and to get sunburned on a hot, sunny day. In this instance, the weather would be known as a 'confounding factor', or an unmeasured factor that influences the proposed cause and effect. In more complicated examples it is not always so easy to separate out these confounding factors, which is a common difficulty in nutrition research.

Disability Adjusted Life Years (DALYS): A measure used to calculate impact on quality of life, expressed in terms of the number of years of good health lost to sickness, disability or early death. It is often used on a population level to capture the full impact of conditions that may have significant quality of life impacts that would not be fully captured looking at death rate

alone, for instance blindness or diabetes.

EPA and DHA: Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are long-chain fatty acids produced by algae and commonly found in seafood.

Food processing: A broad term describing any process that is done to food prior to eating. This can range from simple things like chopping, freezing or cooking to more complex processes like pasteurisation, fermentation or extrusion.

Free and added sugars: These are simple sugars that are very easy for the body to digest and use. They are either added in food preparation or naturally occurring in certain foods like fruit.

Macronutrient: Fat, carbohydrate and protein are macronutrients. They make up a large proportion of the foods we eat and are the nutrients used to provide energy.

Meta-analysis: Along with systematic reviews, these are the most reliable kind of research. Meta-analyses examine data from a number of independent studies of the same subject (ideally randomised controlled trials), in order to determine overall trends.

Metabolic disease: A disease or disorder that disrupts how food is converted to energy within the body on a cellular level. Type 2 diabetes, which disrupts the body's management of sugar, is the most common metabolic disease.

Micronutrient: A chemical element or substance which is required in trace amounts from the diet and is used by the body to mainatian normal functioning.

Morbidity: The rate of disease in a population.

Mortality: The rate of death in a population.

Mycoprotein: A protein ingredient that comes from fillamentous fungi.

Nova classification system: This classification system, devised by Brazilian researcher Carlos Augusto Monteiro, was designed to categorise foods according to their level of processing. The four Nova categories are as follows:

- Nova 1: Unprocessed or minimally processed foods. Minimal processing includes the removal of inedible or unwanted parts. Nothing is added to the original food in this category.
- Nova 2: Processed culinary ingredients. Substances made from Nova 1 foods or from nature that are processed for use in cooking.
- Nova 3: Processed foods. Foods from Nova 1 that have been processed and/or combined with foods from Nova 2, or Nova 2 foods that have been further processed.
- Nova 4: Ultra-processed foods. Foods that have been made using a series of processes, contain artificial ingredients and usually have few intact Nova 1 foods present.

While Nova is not an acronym, it is sometimes seen styled in capital letters.

Plant-based meat: Products that look and cook like conventional animal meat, and aim to recreate the texture and taste using ingredients made from non-animal sources. Even though they technically fall within a different kingdom of life to plants, for the sake of brevity products made from fungi and algae are considered plant-based in the context of this report.

Processed meat: Meat that has been smoked, dried, salted or treated with preservatives such as nitrites or nitrates.

Randomised controlled trial (RCT): The gold standard trial design for generating medical evidence. These trials take a representative sample of people and randomly assign them to either an 'intervention' (the specific change being measured) or a 'control' (a group without the intervention to measure what would have happened if no change had been made). They then compare the differences in pre-defined outcomes between the two groups. Where possible, the study is also 'blinded', meaning the participants in the study (single-blind) and the researchers measuring and collecting the results (double-blind) do not know who is allocated to which group to reduce the risk of unconscious bias.

Red meat: Broadly speaking, this covers meat from mammals, such as beef, pork, lamb, goat and horse.

Systematic review: A synthesis of available evidence on a given topic, using a critical approach to identify, evaluate and weight existing research.

Ultra-processed food: A food that falls within category four of the Nova classification system.

2 Dietary health in Europe

Why is a healthy diet important, and what diet-related health problems are the most pressing for Europeans?

Alongside low physical activity levels and smoking status, diet is a key predictor of health outcomes across European countries. **The 2019 Global Burden of Disease (GBD) study estimated that poor diet is responsible for almost one million premature deaths per year in Europe.**[22,23]

Recent literature has also begun to explore an emerging phenomenon of a 'double burden' of malnutrition, where obesity occurs at the same time as undernutrition. This is a growing problem that has been observed in all regions of the world and is made worse by climate change.[24]

Cardiovascular disease (disease of the heart and circulatory system) is one of the largest single causes of illness and death in Europe, accounting for nearly a fifth of 'disability-adjusted life years' (DALYs) lost. Poor diet is the largest single driver of cardiovascular disease in Europe, responsible for 40% of deaths[25] and has a well-established link with the development of other prevalent conditions such as obesity and type 2 diabetes,[26] and bowel cancer.[27]

Obesity is the most significant driver of diet-related illness and death in Europe. It accounts for 96% of DALYs lost and 99% of deaths[28] resulting from dietary factors. This means that from a public health perspective, enabling people to choose foods that help them maintain a healthy weight, and reduce the risks of the most prevalent diet-related diseases, can have huge benefits.

The health burden of red and processed meat in Europe

The role of conventional red and processed meat in disease development is also increasingly recognised by international health authorities such as the WHO.[29] Many people in Europe eat significantly more than the recommended daily intake of red and processed meat. Research to quantify this impact has estimated that a considerable amount of ill health caused by poor diet can be attributed to overconsumption of red and processed meat.

Red and processed meat are also associated with certain cancers, particularly bowel cancer,[30] while compounds such as resistant starches within plant-based meat are known to reduce bowel cancer risk.[31] Initial studies have also suggested certain plant-based meats may help reduce compounds in the gut linked to these cancers.[32] **Bowel cancer is the second most prevalent cancer and the second largest cause of cancer-related death in Europe.**[33] In the

United States, the American Cancer Society have announced a partnership with plant-based meat company Beyond Meat to explore the potential of cancer risk reduction using plant-based meat.[34]

The GBD study found overconsumption of red meat and processed meat were among the top 10 diet-related risk factors for both ill health and death in Europe. The below graphs show the position of overconsumption of red and processed meat in the context of other major diet-related drivers of ill health.

Figure 1. Top 10 drivers of diet-related ill health in Europe, 2019[35]

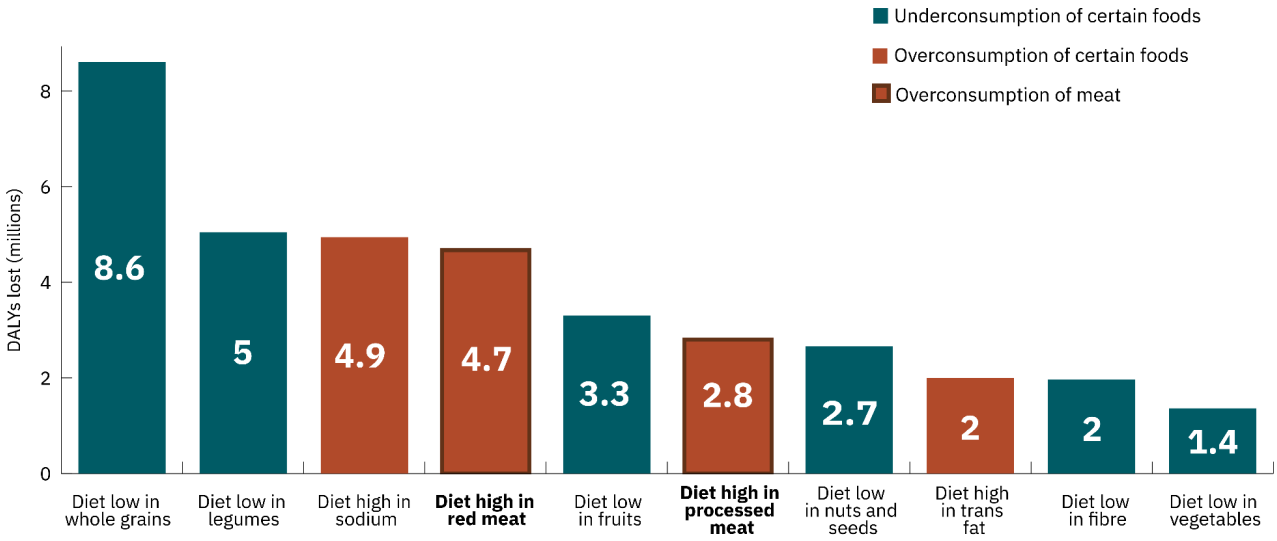
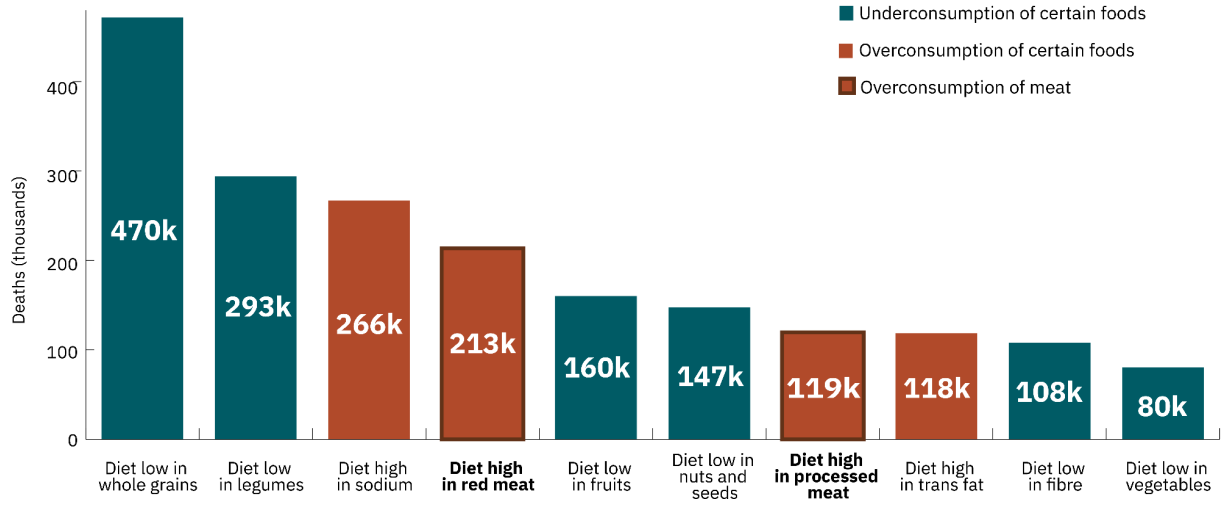


Figure 2. Top 10 drivers of diet-related death in Europe, 2019[36]



About this data: *The GBD study is a global research programme that seeks to quantify causes of death and ill health to inform public health approaches. While it is true that nobody has 'not enough vegetables' on their death certificate, researchers use the data to estimate the net ill health or death caused by these risk factors to better enable comparison and prioritisation.*

3 The challenge of conducting and understanding research on diet

Because food is so fundamental to daily life and linked with many other behavioural and social factors, it is hard to conduct high-quality studies on the impact of diet on health.[37]

The health effects of diet can take years or even decades to have an impact, and isolating them is incredibly hard to do. This is because they are subject to many interconnected influences such as lifestyle, psychology, demographic group, socioeconomic background and genetic makeup.

To complicate this even more, recent research into epigenetics has found that certain lifestyle factors like stress or exposure to pollutants like tobacco smoke can impact health in other ways by altering the way people's genes work.[38]

Poor diets are disproportionately seen in certain groups of people who may share some or all of these other influences. This means it is hard to know which outcomes happened by coincidence, and which were directly caused by diet. This is known as the 'correlation-causation fallacy' and is particularly hard to avoid in research on diet.

This is not the only potential pitfall for researchers, however, as data quality can also be a problem. For example, food diaries are one of the easiest ways to measure and compare dietary differences and are often used in nutrition studies. However, they often give flawed data[39] as there is huge variation in how accurately people can record what they eat.

In addition to this, care needs to be taken when drawing solid conclusions from studies regardless of their type, as studies are only as useful as the question they are answering.

To give an example, a randomised controlled trial looking to compare the impact of foods that are brown in colour could conduct a perfect, well-controlled trial, and find with relative confidence that eating a lot of brown food was linked to poor health.

However rigorous the study, its results would not be particularly useful because being brown isn't a feature of foods that is consistent with their nutritional makeup. The study findings may have resulted from participants eating a particular subset of brown foods like chocolate and cake. These foods can cause problems if eaten in excess, but not because they are brown. Someone reading this study may take away that other brown foods like nuts and whole grains have similar health consequences, which would be untrue.

When conducting scientific research, many different study designs and data sources can be used, each with specific benefits and limitations, as outlined in the table below.

Figure 3: Common study types used in research on diet

	Pros	Cons
Meta-analyses and systematic reviews	• If available, this is the most reliable source of evidence, synthesised from the full body of available research (ideally RCTs).	• Can only be done if other research of sufficient quality already exists.
Human randomised controlled trial (RCT)	• Allows a specific theory to be tested with less chance of other factors skewing results. • Generally the most reliable type of single study.	• Cannot answer some questions as research would be too costly and/or unethical.
Observational study	• Large study population. • Can look at long-term impacts.	• Hard to be sure why things happened.
Data surveys and reviews	• Collect existing data for comparison. • Results are concrete and repeatable.	• Validity of findings depends on the availability and quality of evidence available.
Modelling studies	• Can test a specific theory about a given mechanism without the complexity of 'real life'.	• The mechanism being modelled may not be an accurate representation of real life.
Animal studies	• Easier to conduct than human studies.	• Humans have different physiology from animals, so may respond differently to the same foods.

In short, no one study can give definitive answers on health and nutrition. The only way to build an accurate picture is by looking at multiple, high-quality studies from different authors and institutions and at systematic reviews and meta-analyses, ideally from randomised controlled trials, drawing on the full body of available evidence.

All references used in this report are as far as possible taken from multiple sources with a preference for systematic reviews where available.

4 How do plant-based meat and conventional meat compare nutritionally?

Nutrition is more than just calories. The composition of the foods we eat is a critical consideration in evaluating their healthiness.

All food is made up of different primary building blocks known as 'macronutrients'. These make up the bulk of what we eat, and each provides certain things: some provide energy, some aid growth and repair, and some contain chemical components that drive and regulate the millions of processes that take place in our bodies.

Like the differences between plain white bread and seeded wholemeal bread, the nutritional makeup of different types of plant-based meat can vary a lot. The studies explored in detail in this chapter provide detailed surveys of available products in Germany (2021), the Netherlands (2023), Sweden (2022) and the UK (2021) which can provide average ranges to serve as a yard-stick to compare against conventional meat.

Where relevant, these figures are put in context relative to EU guidelines for health claims on food. Thresholds that do not relate to health claims (high fat, high saturated fat, high sugar and high salt) are taken from the UK traffic light system, as there is no standard EU threshold defining this and it is the simplest national guideline of the countries featured in the graphs.

These averages show that plant-based meats offer upsides (some minor, some major) over their conventional counterparts across most macronutrient categories.

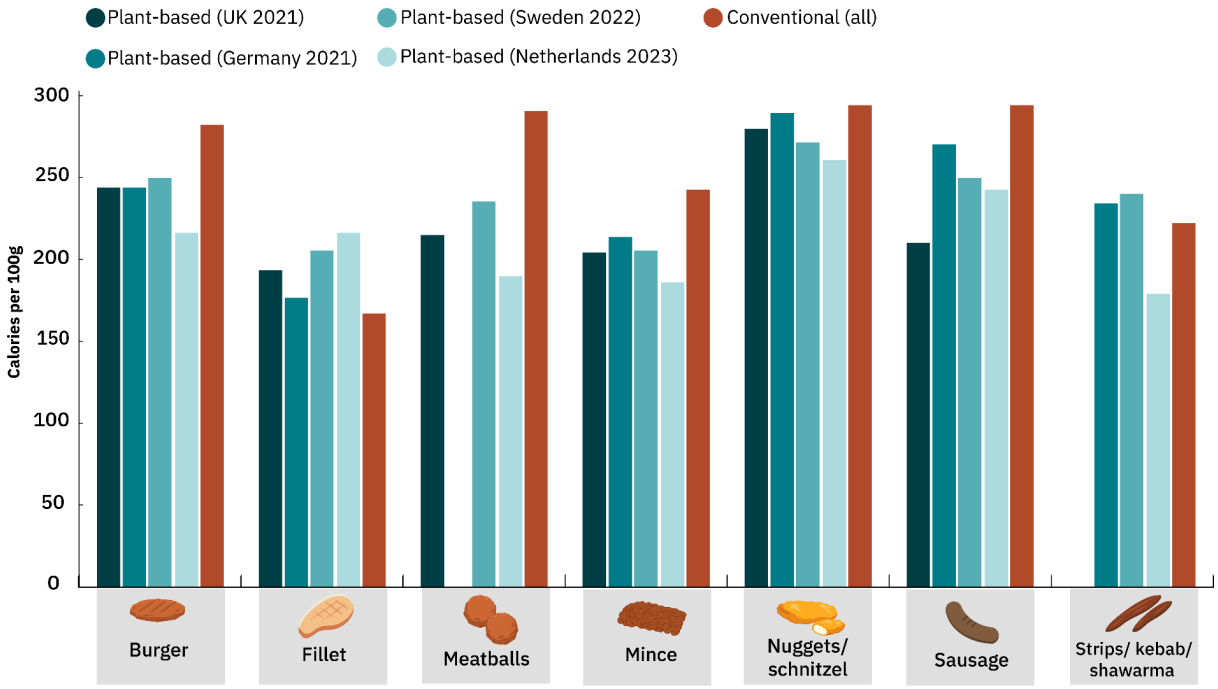
About this data: *Numbers in this chapter from the German, Dutch and UK studies are mean values across products, whereas those from the Swedish study are median values. The German study did not look at meatballs or fibre. The Dutch study did not include total fat, and the UK study did not cover strips or sugar.*

A more recent German study and two Spanish studies have also been conducted on this topic. However, due to different methodologies and product categorisations, they have not been included in this chapter. Please see the appendix for a summary of their findings.

Calories

There is strong evidence that choosing foods with lower calories by weight, generally referred to as "caloric density", can significantly reduce overall calorie intake.[40] On average, plant-based meat products have similar or fewer calories per 100g than their conventional counterparts.

Figure 4: Comparison of average calorie content per 100g in plant-based meat compared to conventional meat.[41,42,43,44]



While a healthy diet is a lot more complicated than simply the energy contained within food, overconsumption of calories is one of the main causes of overweight and obesity, and consequently an important piece of the puzzle. For our ancestors, maximising the amount of energy we could extract and either use or store from our food was essential for surviving periods of scarcity. But, in the context of modern-day Europe, overconsumption of calories is a major driver of diet-related ill health.

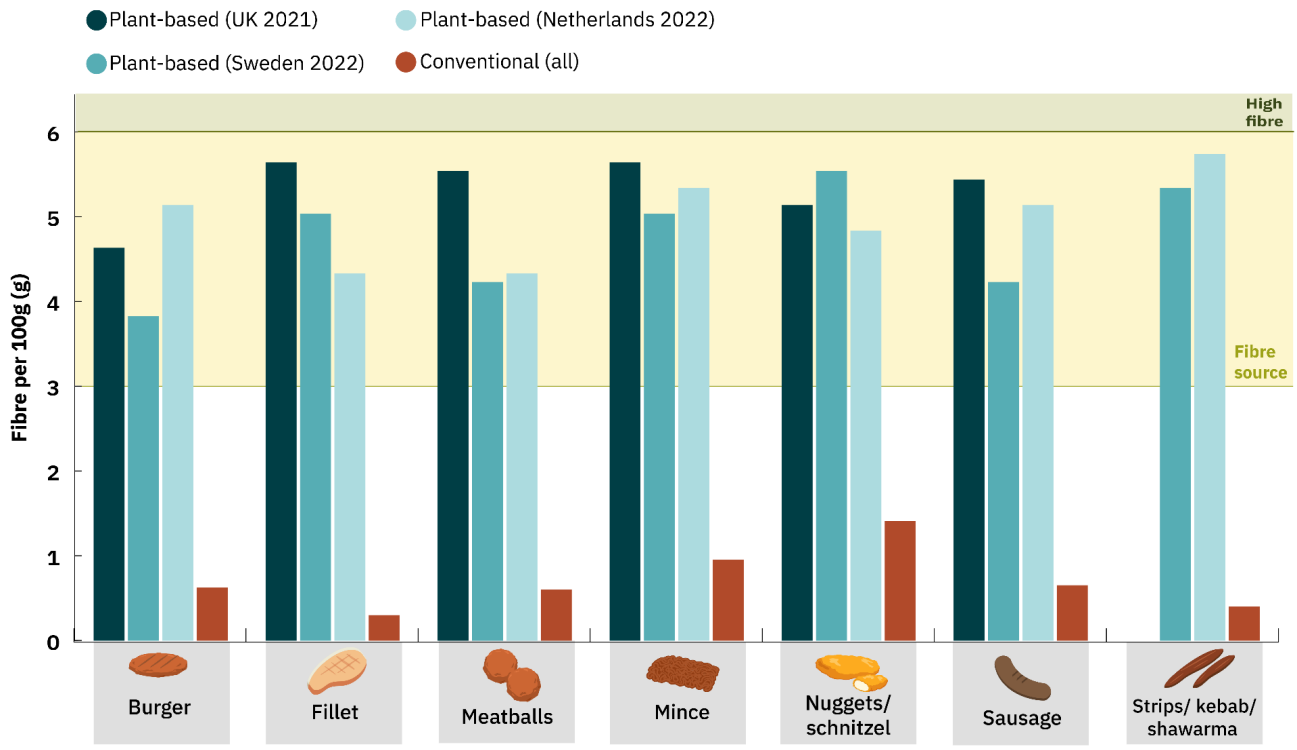
In the studies surveyed here, plant-based meat had similar or fewer calories per 100g in all categories. This difference was mostly modest, but for certain categories, particularly meatballs, there was a significant reduction.

Fibre

There is strong evidence that high fibre intake significantly reduces the risk of cardiovascular disease and death.[45] High fibre intake is also linked to the promotion of a healthy gut and microbiome, and reduction in inflammation.[46] Plant-based meat is considered a source of fibre, while conventional meat is not. The small amount of fibre in conventional meat products is always derived from added plant-based ingredients.

Fibre is an important part of a healthy diet, and there is strong evidence that higher fibre intake is associated with a reduction in the risk of serious diseases such as coronary artery disease, cardiovascular disease, pancreatic cancer, and all-cause mortality.[47] According to European regulators, foods are considered a source of fibre if they have at least 3g of fibre per 100g, and high in fibre if they have at least 6g per 100g or 3g per 100 calories.[48] Dietary guidelines in Europe advise consuming 30g of fibre per day, and the majority of people in Europe do not meet these recommendations.[49]

Figure 5: Comparison of average fibre content per 100g in plant-based meat compared to conventional meat.[50,51,52]

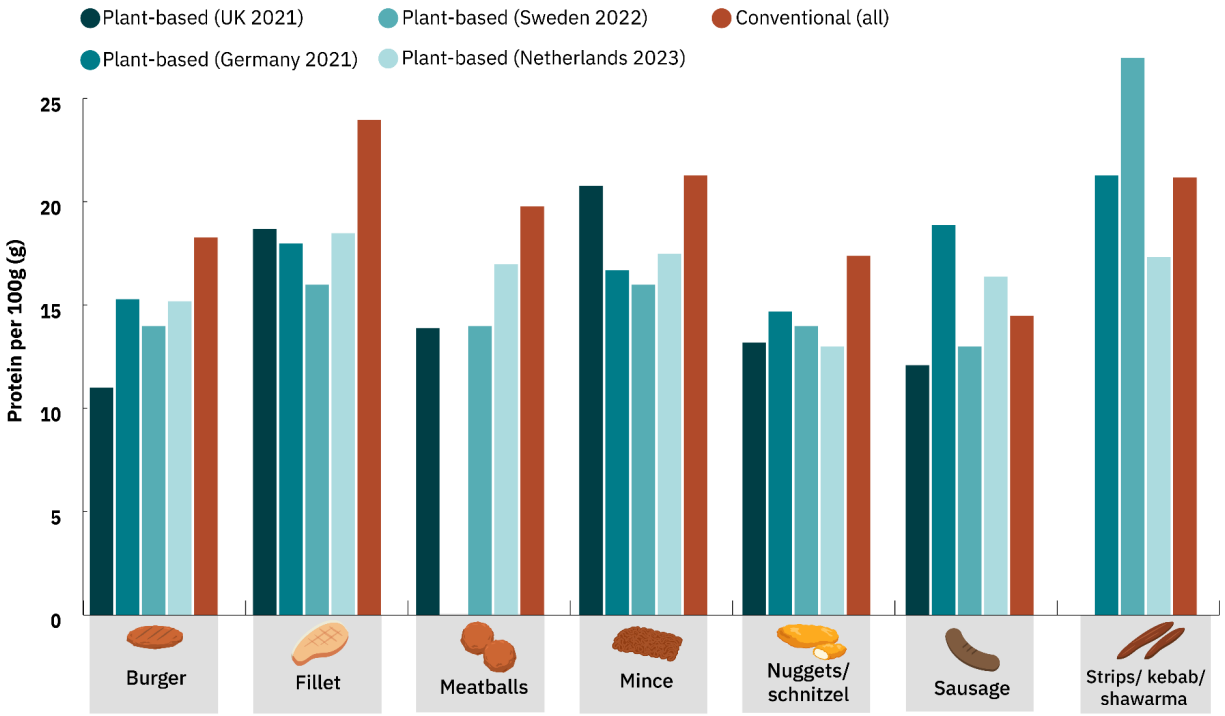


Protein

The evidence on the impact of a high-protein diet on health outcomes is mixed, with different studies finding both positive and negative effects.[53, 54] Plant-based meat comfortably meets the EU definition of a high-protein food, but on average has less protein per 100g than conventional meat.

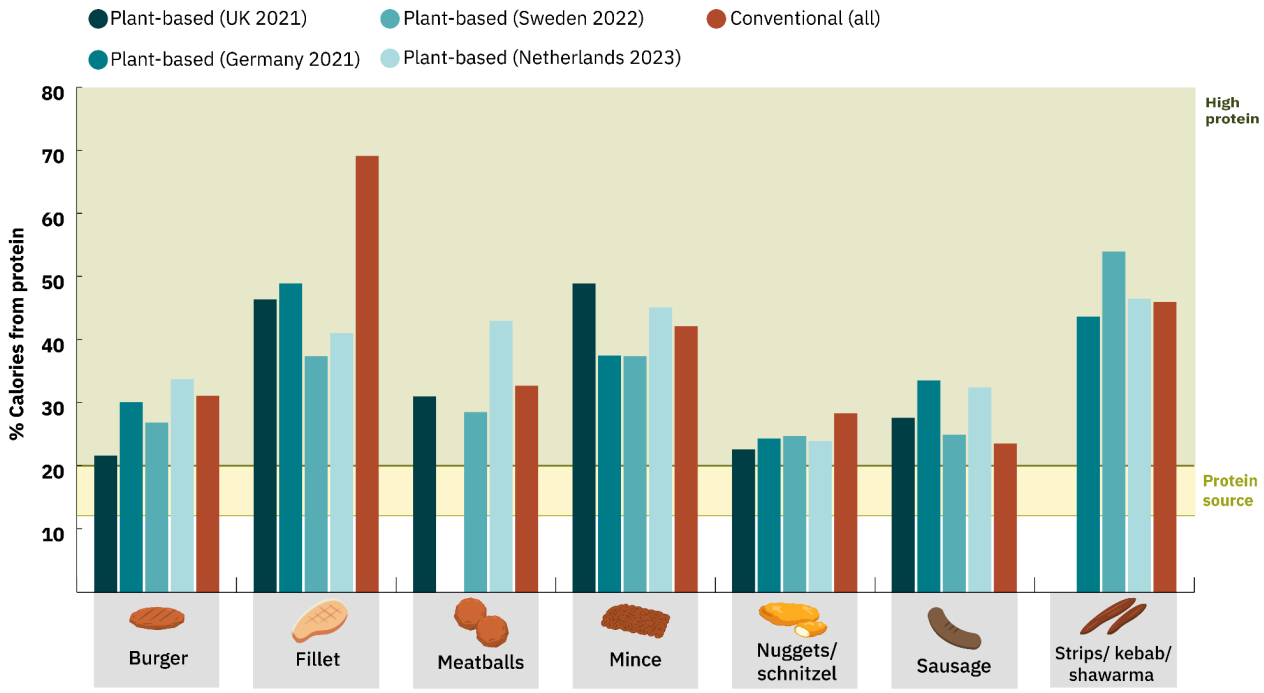
While this is one of the most common concerns from consumers, most Europeans (including vegetarians and vegans) already consume well above their recommended minimum daily protein intake.[55,56] Despite this, protein can still be important to the enjoyment of food as it contributes to the feeling of being 'full', at least in the short term.[57]

Figure 6a: Comparison of average protein content per 100g in plant-based meat available in Germany, the Netherlands, Sweden and the UK compared to conventional meat[58.59.60.61]



Plant-based meat was, for the most part, slightly lower than conventional meat in terms of protein content per 100g across the studies included here. However, nutrition guidelines tend to define nutritional protein sources not just in terms of protein content by weight, but in terms of the percentage of calories in a foodstuff provided by protein (as opposed to other macronutrients like carbohydrates or fat). By this metric, plant-based metric is more similar to conventional meat.

Figure 6b: Comparison of percentage of calories from protein in plant-based meat compared to conventional meat[62,63,64,65]



Plant-based meat is a good source of dietary protein, and all of the plant-based categories featured in these studies meet the European Commission's criteria for high protein foods, with at least 20% of their calories coming from protein. By this metric, plant-based meat is similar to conventional meat across most categories with the exception of a plain fillet.

There is evidence suggesting that consuming plant proteins can reduce the risk of developing chronic diseases such as type 2 diabetes compared to consuming animal proteins.[66] Several studies exploring health impacts associated with replacing animal-based with plant-based proteins have also shown positive findings for cardiovascular health.[67] However, more research is needed to better understand the extent to which this applies to plant-based meats, and what is causing the observed benefits of increasing plant protein consumption.

A person's required protein intake depends on various factors such as age and activity level. For the average person, EU dietary guidelines advise eating 0.83g of protein per kilogram of body weight per day. That is two to three portions of foods that are a source of or high in protein. This requirement is higher for certain groups such as those who are older, pregnant, breastfeeding or athletes.[68,69]

Does plant-based meat contain complete protein?

Proteins are made from building blocks called amino acids. Some of these we can make ourselves, and some we must get from the food we eat (known as 'essential amino acids'). Not all proteins are created equal – and it is important to ensure that across the protein sources someone eats, all essential amino acids are covered.

Protein from animals[70] and fungi[71] are 'complete' – meaning they contain all of the essential amino acids – but this is not always the case in protein from plants.

In humans, there are 20 types of amino acid, 11 of which the body can make itself and nine of which need to come from food. Most plant-based protein sources, such as beans or gluten in bread, are not complete protein sources by themselves. However, many popular simple meals like bean stew with bread combine these, and therefore provide all of the essential amino acids.

However, some plant proteins are complete – and these are often the proteins used as the basis for plant-based meat, soy and quinoa are two examples. Products made from fungi like mycoprotein are also sources of complete protein.[72]

Plant-based meats are also able to use blends of different kinds of protein to achieve an optimal amino acid balance. One example used is the combination of protein from cereals and pulses. Cereals are usually low in lysine while pulses tend to be low in cysteine and methionine – but a combination of wheat and pea protein can provide a complete amino acid profile.[73]

So-called 'incomplete' proteins are valuable in the diet, and plant proteins as a group have been found to significantly reduce the risk of death from heart disease, whereas no beneficial risk reduction was found in equivalent animal protein intake.[74]

How bioavailable is the protein in plant-based meat?

The bioavailability of a nutrient describes how easy it is for the body to break down and use. Plant sources of protein can be less bioavailable, but certain processing methods used to make plant-based meats improve this.[75] Research suggests fungi and algae protein sources have equivalent bioavailability to animal sources.[76]

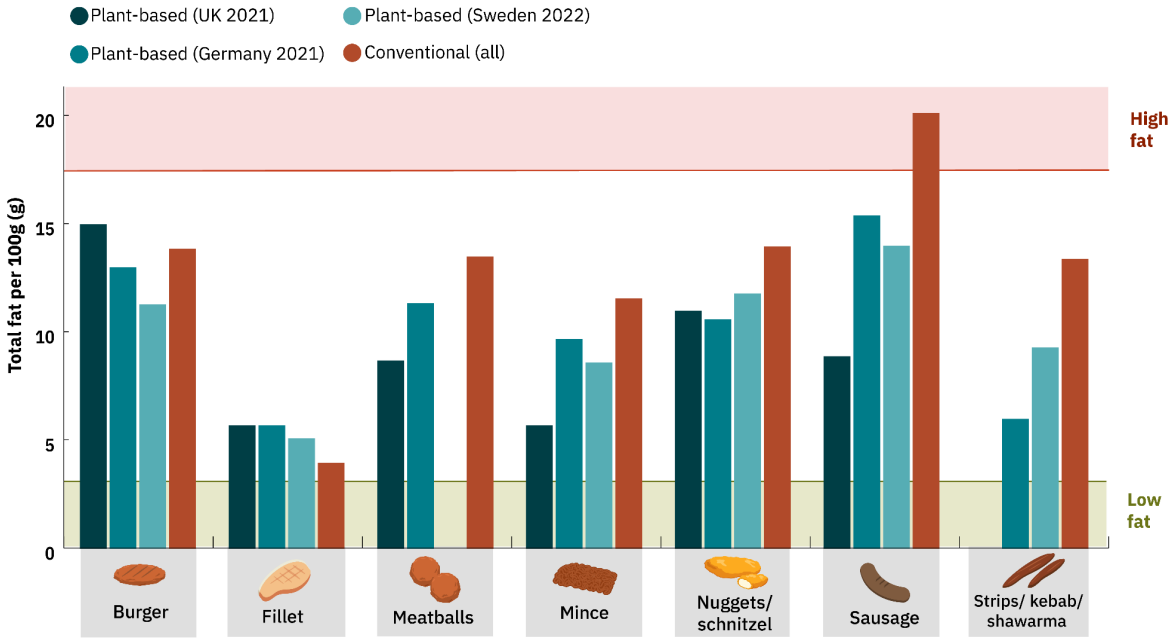
The reason for differences in bioavailability between plant sources of protein and other sources like fungi, algae and animals are so-called 'anti-nutrients' – chemicals that plants produce as a defence mechanism to reduce the digestibility of the nutrients within them.

The processing techniques used to make plant-based meat can offer advantages in bioavailability compared with their raw ingredients by reducing the presence of these anti-nutrients and enhancing other features that improve bioavailability.[77,78]

Fat

Fat is the most energy-dense nutrient, containing nine calories per gram. Diets with lower fat content are therefore likely to result in a lower risk of unhealthy weight gain.[79] There is good evidence that high saturated fat intake is associated with an increased risk of heart attack and stroke.[80] On average, plant-based meats have lower total fat and much lower saturated fat content compared to animal products.

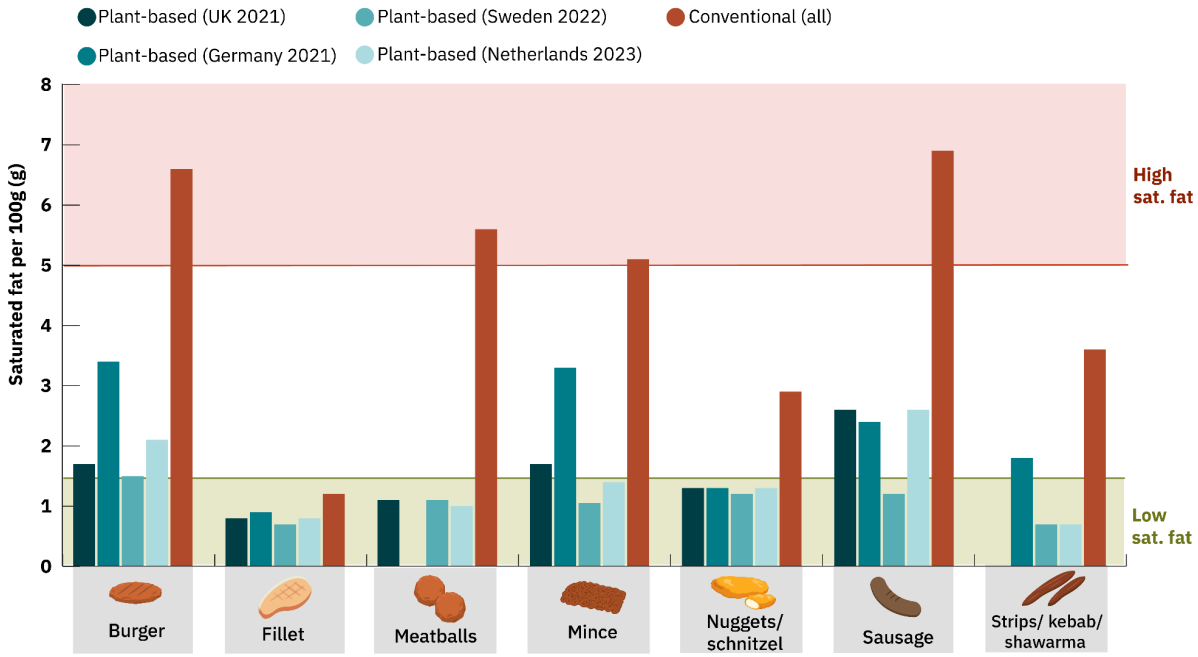
Figure 7a: Comparison of average total fat content per 100g in plant-based meat compared to conventional meat[81,82,83]



The studies found that plant-based meat generally had similar or slightly lower fat content compared to conventional meat, although plant-based sausages tended to have a larger reduction in overall fat. Fat is not inherently bad, and some fat is crucial to a healthy diet – but not all fats are the same.

Where overall fat content was slightly lower, plant-based meat had far lower saturated fat content compared to conventional meat, which was consistent across all product categories apart from fillets, where the difference was modest. Over half of the conventional meat categories studied were high in saturated fat, while none of the plant-based meat categories were and many were low in saturated fat.

Figure 7b: Comparison of average total saturated fat content per 100g in plant-based meat compared to conventional meat[84,85,86,87]



Research shows that high intake of saturated fat is directly associated with an increased risk of cardiovascular events (eg, heart attack and stroke)[88] and that replacing them with unsaturated fat (eg, healthy oils, nuts and seeds) is beneficial.[89] The proportion of fats that are saturated in plant-based meat is significantly lower than in conventional meat, with the fat instead coming from plant-based sources.

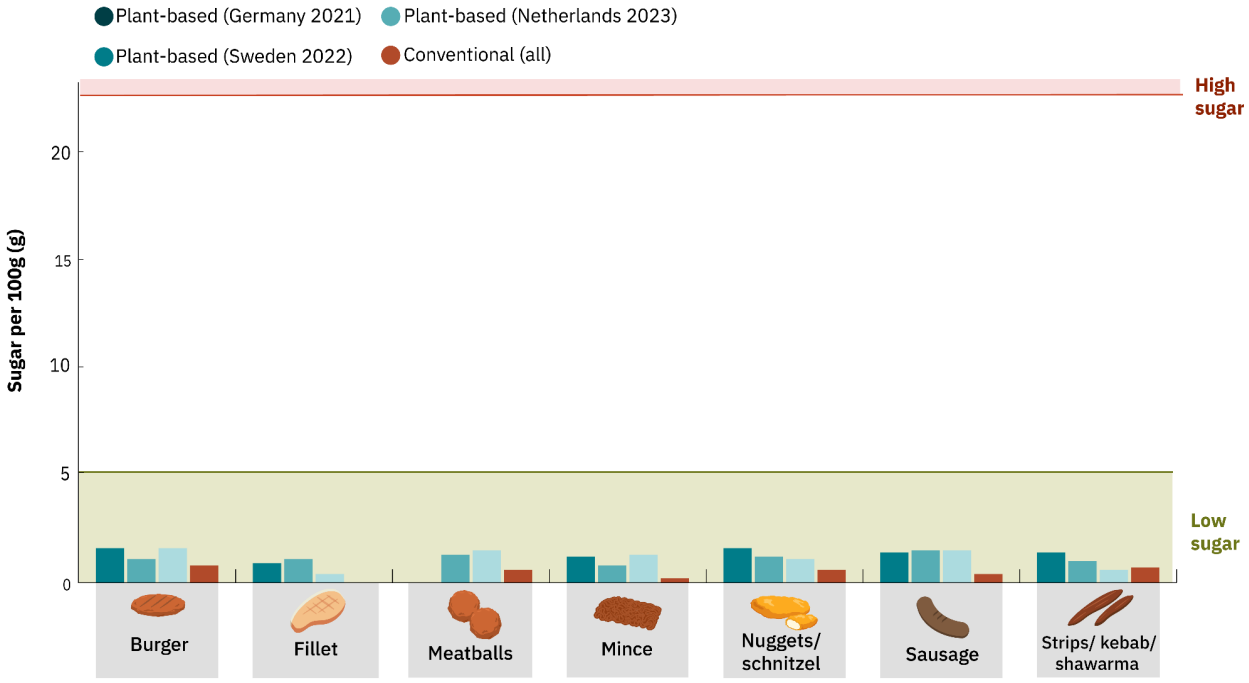
Polyunsaturated fats, in particular, are an important part of a balanced diet and are found in many of the most commonly used oils in plant-based meat. Omega-3 fatty acids found in seeds and algae are also an important part of a balanced diet[90] and are increasingly used to make plant-based meat and particularly seafood products.

Sugar

There is good evidence that most people would benefit from reducing their intake of foods high in free and added sugars.[91] On average, both plant-based and conventional meat are low in sugar (less than 5g per 100g).

Although generally there is more sugar in plant-based meat compared to conventional meat, levels were well within the 'low sugar' threshold across all categories and all countries.

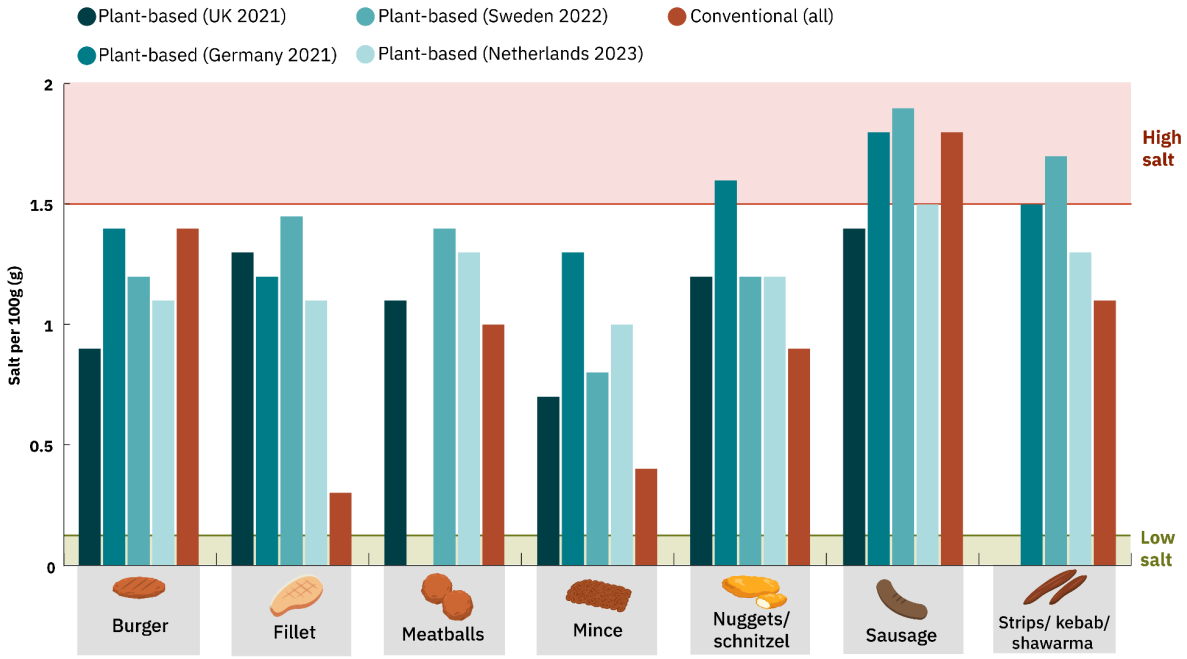
Figure 8: Comparison of average sugar content per 100g in plant-based meat compared to conventional meat[92,93,94]



Salt

Salt is a significant contributor to diet-related ill health, and there is good evidence that most people would benefit from reducing their salt intake.[95] Salt tends to be similar or slightly higher in plant-based meat compared to conventional meat, but large variation exists across categories and countries for both conventional and plant-based products.

Figure 9: Comparison of average salt content per 100g in plant-based meat compared to conventional meat[96,96,98,99]



Some studies have suggested that, in a real-world context, seasoning added during cooking may impact the difference in salt between meals containing plant-based meat and conventional meat, with a randomised control trial led by Stanford University finding no significant difference in salt intake between participants assigned to conventional meat and plant-based meat.[100]

Most European diets contain too much salt, and EU guidelines recommend consuming 6g of salt per day or less. There is good evidence linking high salt intake to high blood pressure,[101] which is in turn associated with serious health conditions such as heart disease and stroke. This has led to calls for more attention to be paid to salt added to foods during production.

Variation has been found in the salt content of both conventional and plant-based meat, and variations by country are particularly significant. Two studies of plant-based meat products in Spain published in 2023 found plant-based meat usually had slightly less salt than its conventional counterparts.[102] Another more recent German study (2023) found plant-based meat had similar to slightly less salt generally, but was significantly lower in the salami

category, where plant-based products had nearly half as much salt as their conventional counterparts.[103] Notably, in further breakdown within the Dutch study (also 2023), processed conventional meat had higher salt content on average than plant-based versions, while salt was slightly higher in plant-based versions of non-processed meat equivalents such as fillets.

Due to differences in methodology and data availability, neither the Spanish study nor the more recent German study are included in these summary tables, but an overview of their findings can be found in the appendix.

Micronutrients

This is one of the areas of greatest potential for plant-based meat in the context of maximising the health dividends of protein diversification.[104] As European diets become increasingly plant-based, plant-based meat has the potential to address some important nutritional needs that can sometimes be harder to fulfil from whole plant sources.[105]

At present, the micronutrient profiles of plant-based meats vary a lot, and this is a growing area of focus within the sector. Fortification has been identified as an important opportunity to facilitate the transition towards healthier, more sustainable diets.[106] At present, some products are fortified to enable them to provide key micronutrients in conventional meat, while others are not, making category-wide generalisations hard.

Interestingly, there is considerable variation not only by product, but also by country in terms of rates of fortification. The studies mentioned in the previous chapter exploring plant-based meats in different countries found that 5% of products in the UK (2021) were fortified with at least one key micronutrient,[107] in the Swedish study 13% were fortified with iron and 6% with B12,[108] and in Australia, 12% were fortified (2023).[109] However, this was significantly higher in the Netherlands, where 55% of products were fortified (2023).[110] This may be related to the guidelines laid out by the Dutch government,[111] which endorse the consumption of plant-based meat products in their national 'wheel of five' guidance tool, so long as they meet certain criteria – including fortification with key nutrients.

Even in Europe, deficiencies in certain nutrients are surprisingly common – part of the so-called double burden of obesity and malnutrition mentioned in Chapter 2. While many of these stem from not eating enough fruits, nuts and vegetables, as diets become increasingly plant-based, more attention may need to be paid to those nutrients that are currently provided primarily by animal products, such as iron, zinc and B12.[112] Like with protein, the bioavailability of nutrients is an important consideration in plant-based foods.[113]

Plant-based meat options with very good micronutrient bioavailability are already available, such as those made from mycoprotein,[114] and research is also ongoing to further improve ingredients made from plants. Progress has been made already, with some plant-based products such as the Impossible burger (at the time of writing in November 2023 not yet available in Europe) containing plant sources of iron with equal bioavailability to that of conventional meat.[115]

Micronutrient needs vary a lot by individual situation and dietary pattern (eg, flexitarians or vegans) and other factors (eg, age or pregnancy). This is a very important consideration, and advice on individual needs should be sought from a qualified professional.

What are the most common micronutrient deficiencies in Europe?

Even in Europe, micronutrient deficiencies are widespread among people following omnivorous, vegetarian and plant-based diets, and are a particularly important consideration for certain demographic groups.

A systematic review of micronutrient deficiency in European countries found several key deficiencies were common. In adult populations, the most common were vitamin C, vitamin D, folate, calcium, selenium, and iodine.[116]

Importantly, as the necessary transition towards a more plant-based food system continues, research has found that fortification of plant-based meat is likely to be one of the simplest and most effective ways to help people reach nutritional adequacy.[117]

While fortification presents many opportunities, there are currently several barriers facing plant-based meat producers that should be addressed. As companies seek to develop products with shorter ingredients lists, they must avoid removing important fortifications that offer nutritional benefits. Additionally, products for human consumption that are fortified cannot be certified as organic, (although animal feed containing the same fortification can be).[118]

These issues present barriers that may be offputting for producers of plant-based meat: if fortification adds costs while also preventing their product from meeting certain criteria that consumers may value like organic or clean-label, they are less likely to fortify their foods.

Key micronutrients for plant-based meat

Plant-based meat has huge potential to meet some of the dietary needs that are particularly difficult to address with an exclusively whole-food plant-based diet, as well as deficiencies that affect the wider European population. Including key micronutrients in their products is an excellent opportunity for plant-based meat companies to deliver significant nutritional benefits through their products.

In certain contexts, plant-based meat could even have advantages over whole-food plant-based options in this regard. A recent study comparing the bioavailability of key micronutrients in a range of plant-based burgers with that of conventional beef found that meat analogues based on soy and mycoprotein were much more similar to conventional meat in bioavailability than vegetable and bean burgers. Notably, the soy and mycoprotein meat analogues were the only options with comparable iron bioavailability, and the mycoprotein

burger was the only plant-based burger found to have comparable zinc bioavailability.[119] This suggests that plant-based meat, and mycoprotein in particular, could have significant advantages for meeting key micronutrient needs compared to other plant-based foods.

Which micronutrients represent the most significant opportunities to deliver nutritional benefits through plant-based meat?

- **B12** is made by certain bacteria that often live in the soil or the digestive systems of certain animals.[120] Most of the B12 in European diets today already comes through fortification, either directly in bread and cereals or indirectly via injections or fortified feed given to farmed animals.[121,122,123]

  There is a great deal of variation in B12 fortification in plant-based meat products, although several products made by some of the more widely available brands in European supermarkets such as the Vegetarian Butcher, Heura, Planted and THIS do contain B12.

- **Iron** is widely available in plant sources and those eating vegan diets tend to eat more total iron than those following omnivorous diets.[124] However, due to bioavailability issues, iron deficiency may still be more common in vegetarian and vegan populations – particularly for those who menstruate.[125,126] More broadly, iron deficiency in general is common, and the anti-nutrient phytic acid means its bioavailability is limited in plant sources. Research has suggested that plant-based meat may offer opportunities to increase iron bioavailability, which is a promising area for further exploration alongside fortification to improve access to iron in the diet.[127,128]

- **Calcium** is an important mineral that is found in abundance in many fruits and vegetables, but again these sources have limited bioavailability.[129] While conventional meat is not a source of calcium, due to prevalent calcium deficiency on a population level this could nevertheless represent an opportunity for enhancing the nutritional profile of plant-based meat. Plant-based meats based on fungi do not face the same bioavailability issues and therefore could have an important role to play alongside the fortification of other options made from plants.

- **Omega-3s.** There are three main types of omega-3 we need from our food, all of which are an important part of a healthy diet: ALA, EPA and DHA.[130] Many plant sources like nuts and seeds are good sources of ALA, but EPA and DHA are made primarily by algae, so it is not very common in food grown on land, and deficiency is common in Europe.[131]

  Production of omega-3 from fish is a significant contributor to overfishing, and current supplies aren't enough to meet the nutritional requirements of the global population.[132] A recent life cycle assessment found production from algae, in addition to reducing pressure on dwindling fish stocks, could also reduce the climate impact of omega-3 production by 30-40%.[133]

A few plant-based meats, in particular some plant-based fish, are fortified with omega-3s but there is an opportunity to increase the prevalence of fortification with algal EPA and DHA to better meet nutritional needs.

- **Zinc.** Again, plant-based (or more accurately fungi-based) meats offer a key opportunity to maintain access to zinc in the context of increasingly plant-based diets.[134] Mycoprotein, given its low levels of phytic acid, likely has similar zinc bioavailability to conventional meat.[135] As such, fortification and diversification of the base ingredients used in plant-based meats represent an important opportunity.

- **Iodine** is another important nutrient that can frequently be lacking in people's diets, mostly found in seaweed and seafood.[136] Like with omega-3, increasing the availability of plant-based sources of iodine with good bioavailability will be important to relieve the pressure on less sustainable sources such as fish.[137]

5 Other benefits of plant-based meat for public health

Nutrition isn't the only relevant health consideration when it comes to plant-based meat. Its potential to fulfil dietary needs without expanding animal agriculture means it could also help to combat several other pressing public health issues such as antibiotic resistance, pandemic risk, food insecurity and climate change.[138]

Even beyond reducing harmful overconsumption of red and processed meat, there are important public health benefits that apply to all types of meat, including leaner meat like chicken and fish. While these can certainly play a role in a healthy, balanced diet, growing demand for these foods is driving other significant public health risks such as antibiotic resistance, pandemic risk, climate change and food insecurity.

Plant-based meat can therefore offer an important public health tool for diversifying the protein supply and reducing reliance on conventional animal agriculture.

Climate change

It is no exaggeration to say that climate change represents one of the biggest threats to public health in the modern era.[139] The 2022 Lancet Countdown report found major threats to global public health on a number of axes, from extreme weather, food insecurity, infectious diseases, respiratory diseases and more.[140]

Animal agriculture is responsible for 20% of global greenhouse gas emissions[141] and is the largest single cause of human-driven methane emissions,[142] a greenhouse gas that is 84 times more potent than carbon dioxide over a 20-year timeframe.[143] Quickly cutting methane emissions is particularly important to slow the rate of warming and avoid breaching key climate tipping points.[144]

Producing plant-based meat has just a fraction of the climate impact of producing conventional meat, reducing emissions by 80-90%.[145] It is also far less damaging to natural habitats, requiring as little as 7% of the land needed to produce conventional meat and 1% of the water. This offers further climate benefits by freeing up land that could be used to restore forests and other habitats that capture carbon, and to enable more sustainable farming practices.

Modelling has found that even partial replacement of conventional meat with plant-based meat would significantly reduce emissions.[146] Plant-based meat therefore represents a relatively

simple solution that could help to address a huge range of the public health risks associated with climate change and overconsumption of conventional meat in Europe.

Antimicrobial resistance

Antimicrobial resistance (where microbes that cause infections and illnesses become immune to antibiotics) is already beginning to render common illnesses untreatable and make routine operations life-threatening. Antimicrobial resistance causes an estimated 133,000 deaths per year in Europe and is responsible for an estimated €1.5 billion per year in healthcare costs and productivity losses.[147]

Animal agriculture uses 50% of all antibiotics in Europe and is well-established as a driver of the growth and spread of antimicrobial resistance.[148] By replacing conventional meat with plant-based meat – which is produced without the need for antibiotics – the pressure on these lifesaving medicines could therefore be significantly reduced.

Pandemic risk

Using animals for food is a key driver of pandemics.[149] The ongoing bird flu pandemic is wreaking havoc both in farmed and wild birds, and is now reported to be spreading between mammal species too.[150] Swine flu in farmed pigs also presents a significant health risk both in Europe and globally. There have been 370 confirmed cases of pig-to-human transmission of the virus since 2009, all of which had significantly reduced susceptibility to flu vaccines.[151] Plant-based meat carries none of these risks because animals are not involved in its production.

Deforestation is also a major driver of pandemic risk because it increases interactions between people and wild animals.[152] Plant-based meat production uses a fraction of the land needed for conventional meat production, and if just 50% of conventional meat were replaced by plant-based meat, the resulting reduction in required land could effectively halt deforestation.[153] This would not only be important to help mitigate climate change and biodiversity loss, but would also significantly reduce pandemic risk.

Food insecurity

War, climate shocks and supply chain vulnerabilities are already driving food shortages – yet Europe currently feeds 45% of all crops it produces to animals.[154] Globally, animals provide just 18% of all calories while using 83% of all agricultural land.[155]

Demand for meat is forecast to grow by over 50% by 2050.[156] To meet this demand, we need a more efficient system.

With the double burden of malnutrition and obesity already at play in Europe and beyond, finding ways to meet important nutritional needs while also reducing the complexity and fragility of our global food systems is paramount. Plant-based meat, which uses up to 93% less land than conventional meat and can provide a variety of nutritional benefits, could play a key role in a more resilient food system.

A report commissioned by the UK Foreign Office and Climate Works Foundation also found that diversifying the world's protein supply by investing in alternative proteins could result in a 10% reduction in global average crop prices by 2050, helping to make balanced diets more affordable all over the world.[157]

Health risks for farm workers

With the ongoing trend towards intensification of animal farming, those working on farms and in meat processing plants have been exposed to increasing occupational health risks, in particular inflammatory and respiratory diseases such as asthma, rhinitis, and COPD.[158] While this has long been recognised, rates of exposure and resulting sickness remain high. Reducing the intensity of animal agriculture by increasing the proportion of plant-based meat could help make it easier to manage and reduce these risks.

6 Frequently asked questions

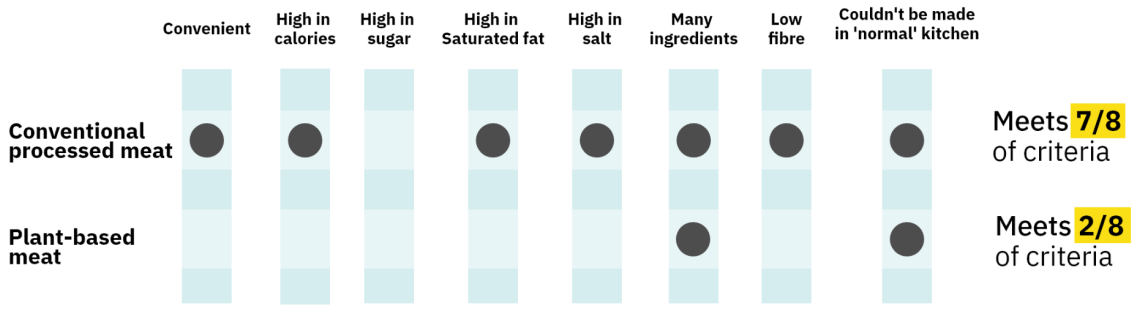
A summary of some of the most common questions people have about nutrition and plant-based meat, with answers.

Isn't plant-based meat ultra-processed? Does that make it unhealthy?

Plant-based meat is one of the product categories consumers most associate with being ultra-processed,[159] but research suggests that the ultra-processed designation may not necessarily say much about how 'healthy' it is.[160] Ultra-processed foods (UPFs) are usually defined according to the Nova classification system outlined in the glossary of this document.

When comparing plant-based meat against the typical definitions used for ultra-processed foods, it is clear that they do not neatly fit (see Figure 11).

Figure 11: Comparison of plant-based meat and conventional processed meat relative to common ultra-processed definition criteria.



Comparison based on GFI analyses of median data from studies into macronutrient profiles of processed meat and plant-based meat in Spain, the Netherlands, Sweden, the UK and Germany. Subjective categories of 'convenient' and 'could not be made in a conventional kitchen' were determined based on standard Nova definitions.

Plant-based meat is rarely mentioned in landmark studies on UPFs, but in various studies (including a meta-analysis) breaking down impacts by food group, UPFs providing a source of fibre, such as plant-based meat, were associated with reduced health risks.[160,161] As seen in Figure 11, plant-based meats tend to have very different nutritional attributes to most ultra-processed food groups, as they are low in sugar and saturated fat and are a source of fibre. In fact, research has found various potential benefits of processing and fortification in plant-based meat. [162]

Conventional meat, however, makes up a sizeable chunk of the ultra-processed foods eaten in Europe,[164] and high consumption has frequently been linked to particularly poor health outcomes relative to other groups of ultra-processed foods. Studies using the NutriNet Sante[164] and Nurses Health Study one and two cohorts[165] also found these associations.

In addition to this, doubt has been cast on the usefulness of the Nova categorisation system more broadly, particularly in the context of scientific research, as the definitions are difficult to consistently apply. This topic is explored in more detail on the GFI Europe website.

How does plant-based meat affect my microbiome?

The microbiome refers to the 39 trillion microbes that call our bodies home. They live on and in all parts of our bodies, in our hair and on our skin, but some of the most important ones live in our digestive systems. There is growing evidence that the gut microbiome could be important in many aspects of health, not only in the gut[166] but also in our immune systems,[167] and for blood sugar managment,[168] heart[169] and brain function.[170]

The considerably higher fibre content of plant-based meat compared to its conventional counterparts suggests it may be beneficial in this respect, as increased fibre consumption is one of the best-evidenced interventions for promoting the microbiome.[171]

This is a relatively new area of research, so more evidence is sorely needed across the board. However, two small randomised controlled trials have so far been conducted on plant-based meat and the microbiome specifically:

- One study looked at the impact of replacing red and processed meat with mycoprotein and found that, over a two-week period, the participants who ate mycoprotein showed statistically significant reductions in genotoxic chemicals in their faeces, and statistically significant increases in the abundance of beneficial gut bacteria.[172]
- Another study explored the effects of replacing conventional meat with plant-based meat in at least five meals per week and also found statistically significant positive changes in the microbiomes of study participants.[173]

Some preliminary studies have also suggested that antibiotics used in farmed animals can enter the human food chain through animal products and disrupt the microbiome,[174,175] but again much more research into this is needed.

Literature reviews looking at the influence of conventional meat as a whole on the microbiome have not identified any conclusive findings.[176] One systematic review looking at beef found that excessive consumption had negative effects on participant microbiomes – but again noted the need for more and better quality studies.[177]

There is more but still limited evidence that plant-based and vegetarian diets as a whole tend to promote the health of the microbiome.[178]

There are also concerns that UPFs may contribute to negative changes in the gut microbiome.[179] Low fibre content, high levels of refined sugars, high fat, and the presence of certain additives such as artificial sweeteners have been proposed as possible reasons for this.

However, there is no evidence to suggest that the processing techniques used to make plant-based meat, which is a source of fibre, low in sugar and saturated fat, and unlikely to contain artificial sweeteners, negatively affect the microbiome.

Does plant-based meat contain complete proteins?

For the answer to this question, see the section on protein in chapter four of this report (page 19).

Doesn't plant-based meat have lots of ingredients and additives?

Most of the food in supermarkets, including both conventional and plant-based meat products, contain additives. All food additives used in Europe must meet stringent food safety criteria, requiring a large body of high-quality evidence in order to be approved for use.[180] However, recently some concerns have arisen that certain additives may have previously undiscovered effects.

Preservatives, emulsifiers, gelling agents, thickeners and sweeteners are some key groups that are often discussed in these contexts.

Preservatives

Preservatives are important for improving shelf life and reducing food waste. Salt is a simple preservative but other ingredients are also used for this purpose. Recent research has found that added nitrates, nitrites and nitrosamines, which are most commonly used in processed conventional meat products,[181] may be linked with increased cancer risk.[182, 183]

Emulsifiers

Emulsifiers are the most commonly used additive group in all foods. In plant-based meat, they are used to create a juicy meat-like texture. Emulsifiers are also naturally found in many whole foods such as eggs, seeds and legumes, and are also frequently made within the body.[184]

Some researchers have argued that emulsifiers may contribute to some of the negative health correlations seen in studies on ultra-processed foods,[185] but the studies underpinning these claims have been subject to substantial expert criticism.[186]

Some of the most common emulsifiers discussed and/or used in plant-based meat, and the research into their specific health impacts, are as follows:

- **Xanthan gum**: As a long-standing and frequently used emulsifier, Xanthan Gum has been explored in a variety of high-quality randomised controlled trials and follow-up real-world studies. A report compiled for the European Commission and published in 2017 found Xanthan gum to be very safe, with no notable adverse effects even in the highest exposure studies.[187] This was found to be true across all age groups including children and infants.

- **Plant-based lecithins:** These are a well-established group of emulsifiers for which extensive health evidence is available from both randomised controlled trials and real-world data. Again, a review conducted for the European Commission and published in 2017 found them to be very safe, with no adverse effects noted even in the highest exposure studies.[188] Allergenicity for those with a soy allergy was the main identified risk. Several preliminary studies have also identified potential health benefits of soy lecithin including lowering blood pressure,[189] and reducing cholesterol,[190] although these effects are debated.[191]

- **Methylcellulose and hydroxypropyl methylcellulose:** These are well-researched and understood emulsifiers (also used for some other useful properties like gelling) that are not only considered safe but are thought to carry health benefits that have been validated by the European Food Safety Authority (EFSA).

  Methylcellulose achieved some notoriety in the United States after it was the subject of an attack ad against plant-based meat, which revolved around methylcellulose being difficult to spell.[192]

  The EFSA's systematic review of trial data was positive, however, and found hydroxypropyl methylcellulose could help blood sugar management and reduce cholesterol.[193]

  There has also been research recommending the addition of hydroxypropyl methylcellulose as an animal fat replacer to improve the nutritional value of conventional meat products.[194]

- **Plant protein isolates:** Potato and fava bean proteins are commonly used as emulsifiers in plant-based meat. There are no noted health concerns associated with them, and preliminary studies have suggested they could be beneficial for slowing the rate of digestion and improving blood sugar control.[195]

- **Sweeteners**
  Since plant-based meats are savoury products, sweeteners are rarely used in them. As an additive group, the health effects associated with artificial sweeteners have not been conclusively proven.[196] A systematic review published by the World Health Organisation in 2022 found that non-sugar sweeteners may have small short-term impacts on glucose metabolism and result in lower body weight when coupled with calorie restriction. However, it found no clear consensus on their long-term impact on weight loss or maintenance, and therefore recommended against using them for weight management.[197]

What about the bioavailability of protein and micronutrients?

This is addressed in chapter 4 of this report, both for protein (page 19) and micronutrients (page 26).

Do athletes need animal protein to build muscle?

The short answer to this is no. In fact, many high-level athletes, particularly in endurance sports such as cycling and running follow increasingly plant-based diets, which research suggests could benefit both cardiovascular safety and performance.[198] Some research suggests that for elite athletes, consideration of the type of plant protein used could influence their capacity for building muscle.[199,200] Advice on specific diets for athletes should be sought from a qualified professional.

Why bother with plant-based meat at all? Isn't it better to just eat plant-based whole foods?

Research has repeatedly found that plant-based whole foods like fruits, vegetables, beans, nuts and whole grains are incredibly good for you.[201] Not only are they very healthy, but many are cheap and readily available. However, this has long been the case, yet overconsumption of meat remains a problem, very few people eat enough plant-based whole foods, and even fewer eat an exclusively whole food, plant-based diet. This suggests that, while increasing the availability and accessibility of plant-based whole foods is important, alongside this, options like plant-based meat may be easier and more appealing for consumers to incorporate into their diets as they transition towards more plant-based ways of eating.

Plant-based meat plays a very different nutritional role from most plant-based whole foods. For example, research suggests that groups with the highest consumption of plant-based meat products also tend to eat more plant-based whole foods than average.[202,203]

As seen in Figure 13, plant-based meat usually has a higher protein content per 100g compared to a lot of whole-plant protein sources. This higher protein content can contribute to

stronger feelings of satiety after a meal, and can therefore be an easier switch for consumers to make when increasing the proportion of plant-based foods in their diet.

Figure 13: Comparison of protein content per 100g between various plant-based whole foods, plant-based meat and conventional meat.

Food	Protein per 100g
Lentils (canned, drained)	9g
Chickpeas (canned, drained)	9g
Garden peas (frozen)	5g
Cashew nuts	17g
Sunflower seeds	20g
Portobello mushroom	2g
Tofu (silken/firm/extra firm)	6g/9g/17g
Plant-based pea burger (Heura)	19g
Plant-based mycoprotein burger (Quorn)	17g
Conventional beef burger	18g
Conventional chicken burger	21g

Properly fortified plant-based meats also make it much easier to meet recommended intakes of key micronutrients like B12(not found in plants), calcium, iron and zinc (limited bioavailability in plants).[204] The way plant-based meat is made can improve the bioavailability of these important nutrients.[205]

Research shows that 90% of plant-based meat consumers are not vegetarian or vegan[206] – but fall into the 'flexitarian' category, replacing some of the meat in their diet with plant-based options. Plant-based meat offers these people a way to get some of the health advantages of plant-based whole foods without having to radically change the way they cook and eat.[207] This does not take away from the value of consuming more plant-based whole foods, which, as explored above, plant-based meat eaters also tend to eat more of than average.[208,209]

With the need to dramatically reduce the amount of conventional meat in our diets growing ever more pressing, plant-based meat could be an important tool alongside plant-based whole foods to deliver the change needed fast enough, while also positively impacting nutrition by reducing harmful overconsumption of red and processed conventional meat.

Does this apply to everyone? What about groups with special dietary needs like older adults and those who are pregnant?

It is not in the scope of this report to give specialist health advice, and anyone concerned about making sure they are getting everything they need from their diet should consult a qualified health professional. That said, there is nothing to suggest there would be anything wrong with these people eating plant-based meat as part of a healthy balanced diet.

What about plant-based milk and eggs?

Due to the size and complexity of this topic, only plant-based meat is reviewed here. A brief summary of milk by Dr Hannah Ritchie of the University of Oxford found that plant-based milk was generally lower in fat and sugar, as well as protein (with the exception of soy milk). Due to fortification, plant-based milk had comparable or higher levels of key micronutrients, but bioavailability was not explored.[210]

7 What work is being done to further enhance the nutritional value of plant-based meat?

Beyond their sustainability credentials, plant-based diets have long been recognised for their value in improving health. As the nutritional benefits of plant-based foods have entered the spotlight, companies and researchers in the field are increasingly focused on nutrition as they develop next-generation products.

Take a look below at some of the hottest topics in modern nutrition and the research into how plant-based solutions can address them.

Maximising micronutrients

Plant-based meat offers a whole new area of opportunity for improving the nutritional quality of the protein on people's plates. Fibre is one great example of this that is already present: swapping a portion of conventional meat for a portion of plant-based meat significantly increases the fibre content of the meal – something most people do not get enough of in their diet.[211]

However, research is also ongoing to maximise the micronutrient content and availability in plant-based meat, overcoming bioavailability issues sometimes seen with plant-based foods.

For instance, researchers at the University of Leeds are investigating ways to remove so-called 'anti-nutrients' from a wide variety of pulses, cereals and oilseeds to maximise the digestibility of the protein and micronutrients within them.[212]

Finding more sustainable ways to produce the omega-3 fatty acids EHA and DPA is also a big focus, alongside developing ingredients that remove the fishy taste some may find offputting and making these important nutrients available in higher concentrations. Most consumers today get these fatty acids through eating oily fish, but dietary needs worldwide already exceed supply from conventional seafood and are a driver of overfishing.[213] Algae omega-3 has been available for a long time, but new research to improve algae-based ingredients by removing fishy flavours could broaden the types of foods containing these important fats, making them more easily accessible.

Research is also ongoing to diversify the crops we grow and identify optimal ingredients for making plant-based meat. Many of the crops grown today have been specifically bred as feed for animals, which has limited their utility in plant-based meat and human consumption more broadly. This is an issue that a transition towards plant-based eating patterns could address

more broadly, as the demand for animal feed is driving the trend towards intensive monocultures which threatens food security and biodiversity.[214]

Plant-based meat offers a huge opportunity to create value for farmers growing more diverse and local crops, in doing so improving food security and biodiversity. Denmark has been a leader in this space, with the government investing €168 million in 2021 into a new fund focused on advancing research into diverse organic crops, and their applications in creating delicious, nutritious plant-based foods. In addition to this, the Plant 2 Food initiative created by the Danish Novo Nordisk Foundation funds open-access research into new kinds of crops that can provide more diverse and nutritionally varied ingredients for plant-based foods.[215]

Conducting essential health research

Generating more high-quality evidence on the health impacts of swapping conventional meat for plant-based – particularly over the long term – will be crucial for improving plant-based meat products. However, conducting high-quality randomised controlled trials is very expensive and so far public funding for such research has been limited. This cost, as well as public perceptions that research funded by companies is unreliable, is also a barrier to businesses interested in supporting this work.

Nevertheless, some pioneers have been working to build the evidence base on this important topic by investing in research into the health impacts of plant-based meats:

- GIANT LEAPS and the Smart Protein Project are two initiatives, funded by Horizon Europe, that conduct research into various aspects of protein diversification, nutrition in particular. Their research aims to understand and address key issues like micronutrient and protein bioavailability, among other things.
- Mycoprotein pioneers Quorn are also leaders in this space, having collaborated with various universities to conduct a number of studies demonstrating the potential for mycoprotein to reduce cholesterol,[216] support muscle growth and maintenance,[217] and support a healthy microbiome.[218]
- Beyond Meat are also committed to nutrition research, conducting the landmark SWAP-MEAT randomised controlled trial,[219] gaining accreditation from the American Heart Association, and working with the American Cancer Association in a multi-year partnership to explore the potential for plant-based meat to reduce cancer risks.[220]
- Health is also the focus of a number of initiatives within the sector, such as the Healthy Plant-Based Foods Accelerator, part of the Sheffield Hallam University Centre for National Food Excellence.[221] This project identifies startups and companies with promising innovations for improving the health and sustainability of foods, and provides access to expertise and pilot facilities to help de-risk this research and scale up production.
- Research at the University of Wageningen is also exploring ways to optimise the development of protein isolates that preserve key nutritional elements and also improve efficiency.[222]

8 Conclusions and recommendations

Swapping conventional meats for plant-based versions could have significant public health benefits in Europe – both in terms of nutrition, and in addressing pressing public health challenges such as climate change, antibiotic resistance, pandemic risk, food insecurity and more.

Plant-based meats offer people a straightforward swap that can meaningfully improve the quality of their diets without requiring significant behaviour change – while simultaneously delivering significant public health benefits.

Taste and price are among the most significant barriers for consumers seeking to change or improve their diets[223] – so, for many consumers, the idea of swapping their favourite meat for beans, nuts and vegetables is unrealistic. But as plant-based meats continue to get closer to taste- and price-parity with conventional meat, they have huge potential to help people reduce their consumption to recommended levels, boost their fibre intake, and reduce saturated fat intake.

To accelerate progress and ensure plant-based meat delivers on this potential, governments must invest in research and development to deliver next-generation products that have even better nutritional profiles and achieve mainstream appeal through improved taste and lower prices.

The public health potential of shifting towards more plant-based diets such as that outlined by the EAT Lancet Commission [224] has been recognised by many leading health organisations such as the European Society for Cardiology[225] and the Physicians Association for Nutrition.[226] Plant-based meat products meeting specific criteria are recommended in Dutch national nutrition guidance,[227] and by leading health charities such as the British Dietetics Association.[228] However, more work is needed to make nutritional profiles more consistent to allow for broader recognition, as is already seen with plant-based dairy.

Key priorities to optimise and communicate the health benefits of plant-based meat

Research priorities

Funders should invest in advancing research in the following key areas:

- **Developing next-generation plant-based meat products** to enable optimisation of nutrient bioavailability and taste, as well as improving functionality and broadening the range of available options, such as whole-cuts, that fit easily in healthy balanced meals.
- **Diversification of ingredient crops and expansion of breeding specifically for use in plant-based meat.** This will improve the functionality of raw ingredients, reducing the number of processing steps and additional ingredients needed. It will also enable further improvements in nutritional value and allow more protein crops to be grown locally.
- **Developing novel processing technologies** (including the use of fermentation) which are better able to maintain or further boost the nutritional value of plant-based ingredients.
- **High-quality trials investigating the health impacts of swapping plant-based for conventional meat** to bolster the evidence base underpinning the important role of plant-based meat in public health.

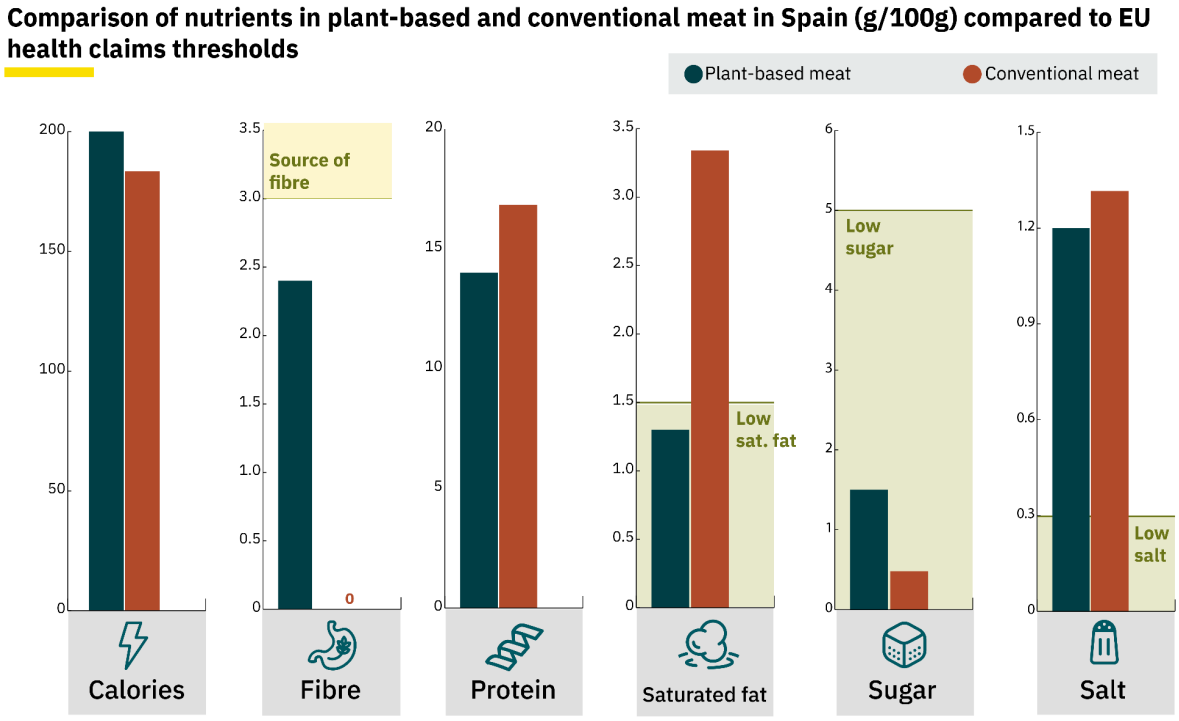
Company priorities

- **Better communicate the health benefits of their products to consumers.**
- **Continue to explore ways to enhance the nutritional quality of plant-based meat through approaches such as micronutrient fortification and salt reduction.** This will ensure plant-based meats can fulfil the same role as conventional meat in people's diets, while also offering additional benefits.

Appendix

Additional data from Spain

Figure 14: Summary of the nutritional makeup of plant-based meat and conventional meat in the Spanish market[229]

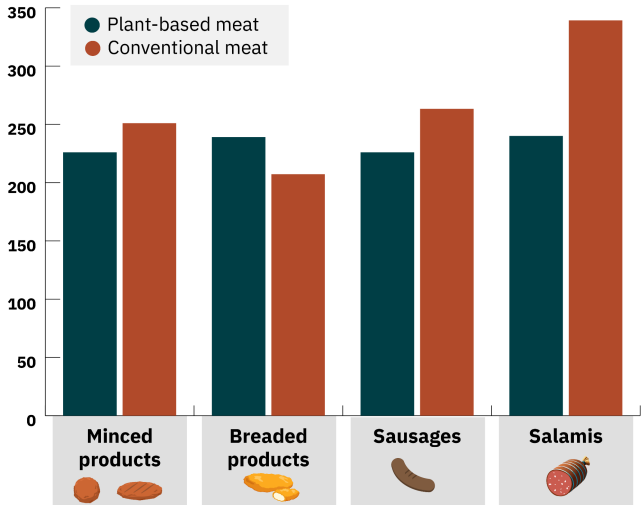


In this Spanish study, findings were broadly consistent with other studies, although fibre was slightly lower than other studies. Another more detailed 2023 study with category breakdowns of the Spanish market found fibre content to be higher than in the above graph,[231] but the data was not available for use in this report.

Additional data from Germany

Figures 15-19: Summaries of the nutritional makeup of plant-based meat and conventional meat in the German market, taken from the most recent study in 2023[232]

Comparison of calories per 100g in plant-based and conventional meat in Germany (2023)



Calories

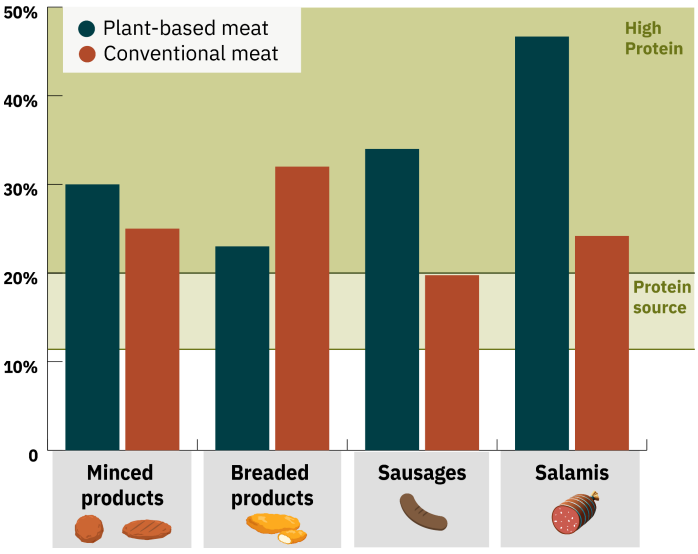
Calories in the German study were usually lower in plant-based compared to conventional products. By category, they were significantly lower in plant-based salami, similar but slightly lower in sausages and minced products, and similar but slightly higher in breaded products.

Protein

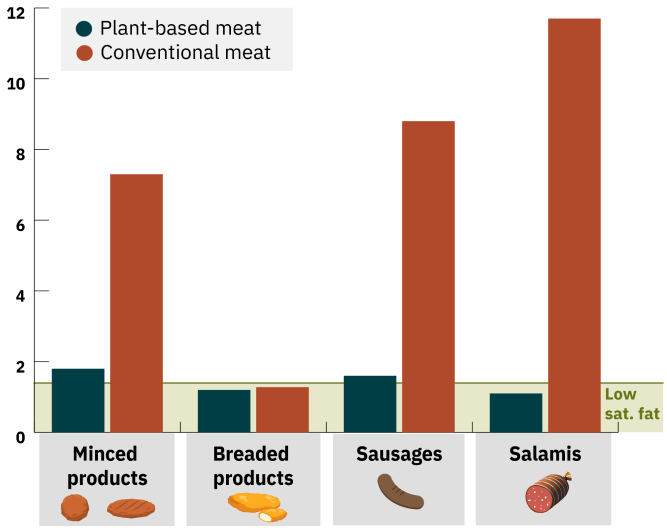
All plant-based product categories met the threshold for high protein. Most conventional products were high in protein except for sausages which fell at the top of the source of protein threshold.

In general, a higher proportion of the calories in plant-based meat products came from protein. This was significantly higher in the sausage and salami categories, and slightly higher in the minced product category. It was, however, lower in the breaded category.

Comparison of % calories from protein in plant-based and conventional meat in Germany (2023)



Comparison of saturated fat (g/100g) in plant-based and conventional meat in Germany (2023)



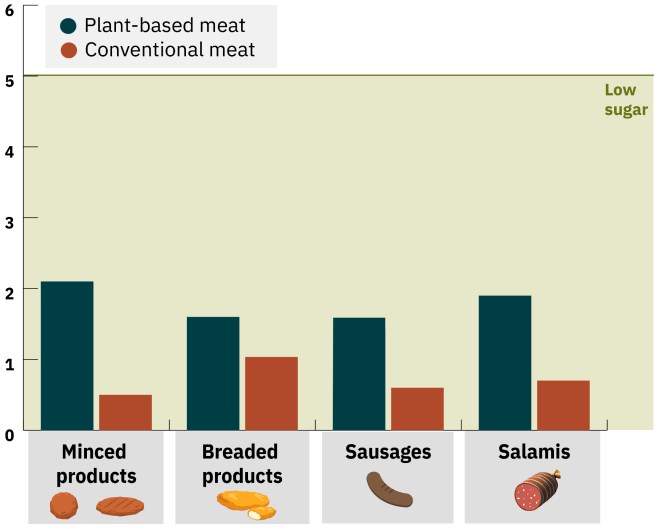
Saturated fat

This was the most significant area of difference between plant-based and conventional products in Germany. Of the plant-based products, two were low in saturated fat and two were slightly over the low threshold. While conventional breaded products were only slightly higher than plant-based breaded products and both were low in saturated fat, conventional minced products, sausages and salamis were all much higher in saturated fat.

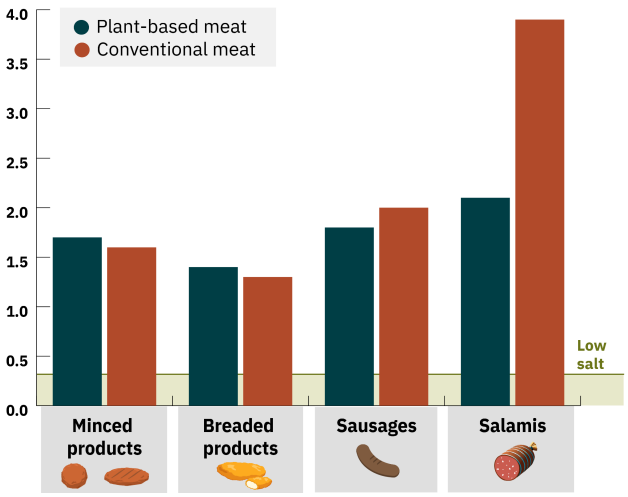
Sugar

Plant-based and conventional products across all categories fell well within the low sugar threshold, although plant-based meat did have more sugar in all categories.

Comparison of sugar (g/100g) in plant-based and conventional meat in Germany (2023)



Comparison of salt (g/100g) in plant-based and conventional meat in Germany (2023)



Salt

None of the categories of either plant-based or conventional products were low in salt. In most categories, both plant-based and conventional products were similar, with plant-based minced and breaded products slightly higher in salt and plant-based sausages slightly lower. However, there was a significant difference in salt content in the salami category where conventional salami had almost double the amount of salt compared to plant-based salami.

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