# Are Plant-based Meat Alternatives a Better Choice? Comparing the Consumer Perceptions, Among Other Factors of Plant-based Meat Alternatives Against Animal Origin Products.

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**Technological University Dublin**

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# *Are Plant-based Meat Alternatives a better choice? Comparing the consumer view, sustainability, processing and health factors of Plant-based Meat Alternatives against animal origin products.*

***A Thesis Presented as part fulfilment for the Award of by***

**Joseph de Andrade Perez B.Sc.**


For Research Carried Out Under the Guidance of

Dr. Áine Behan

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# Declaration

I hereby certify that the material, which I now submit for assessment on the programme of study leading to the award of Master of Science in Food Business Management and Technology, is entirely my own work and has not been taken from the work of others save to the extent that such work has been cited and acknowledged within the text of my own work. No portion of work contained in this thesis has been submitted in support of an application for another degree or qualification to this or any other institution.

Signed:  Date:29.05.22

Student Name Joseph de Andrade Perez

I/We hereby certify that the unreferenced work described in this thesis and being submitted for the award of Master of Science in Food Business Management and Technology is entirely the work of Joseph de Andrade Perez. No portion of the work contained in this thesis has been submitted in support of an application for another degree or qualification to this or any other institution.

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# Abstract

Meat consumption is a substantial contributor to the damaging impacts that are caused to the environment. Alternatives to meat that are derived from plants have been on the market for some time and can now be found with relative ease at supermarkets in Ireland. This study was conducted with the intention of identifying the Irish population's perceptions and attitudes around eating meat substitutes and their likelihood of switching or using them in the future. The rationale around this research was due to the fact that the consumption of such plant-based meat alternatives is now fairly low in the Irish population and globally in general.

In order to accomplish these goals, an online survey of Irish consumers (N = 136) was carried out to examine the lifestyles of customers and their opinions about plant-based meat alternatives in terms of consumption, environmental impact, processing, and nutritional value. A tasting session was performed to determine the organoleptic differences between the various products in order to provide additional findings regarding the preference of consumers for traditionally produced meat products over plant-based alternatives to traditional meat products.

The findings suggest that despite meat's reputation for having favourable organoleptic qualities such as its look, texture, taste, and smell, this association is not entirely justified. Traditional meat products have a worse reputation when it comes to issues of environmental responsibility and sustainability. This would imply that replacement needs to have comparable favourable organoleptic characteristics, but also provide a good healthy product.

In point of fact, plant-based alternatives to meat were thought to be more environmentally friendly, and also an opportunity to provide a healthier option to meat if the nutritional qualities were found to be favourable. When it came to promoting this plant-based product on shelves, naming was a significant element. Instead of linking to meat names, the customer preferred clarity when calling the product, such as soy-based burger instead than beefless burger. In conclusion, the findings of this study indicate that alternatives to meat have the greatest potential to

successfully displace meat when, in terms of both taste and texture, they are most similar to highly processed meat products and when they are sold at prices that are comparable to those of meat.

## List of Abbreviations

| | |
|---|---|
| **T-Test** | Student's t-test |
| **P-value** | Probability Value |
| **PBMAs** | Plant-based meat alternatives |
| **TCFG** | The Culinary Food Group |
| **TMPs** | Traditional Meat Products |
| **TVP** | Textured soya bean products |

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# Chapter 1

## Introduction

## 1.1 Introduction to Plant-Based Meat Alternatives

Plant-based Meat Alternatives (PBMAs) are products made from plant-based proteins that are similar in taste and feel to meat are referred to as meat substitutes. In spite of the fact that it was developed by ancient Asian civilizations a very long time ago, it has only recently become a topic of considerable interest as a result of environmental catastrophes, difficulties in human health, and concerns regarding animal welfare (He, et al., 2020).

(Mistry, et al., 2020) state that a product that takes the place of meat is sometimes referred to by a variety of names, including "meat alternatives," "meat analogues," and "meat substitutes." However, there are a few key distinctions to keep in mind between each of these words. Due to the significant amount of protein that they contain, for instance, spirulina pills or a protein bar might be categorised as a replacement for meat. On the other hand, one cannot count on it to take the place of meat that comes from animals. PBMAs include items such as soy mince and Quorn burger, both of which are examples of proteins that imitate the taste, look, and texture of animal-origin goods in addition to other organoleptic properties. Some meat substitutes are manufactured by altering the proteins found in legumes and cereal grains such that they have the consistency of genuine meat. The fact that certain plant proteins are nutritionally incomplete (they do not include all of the required amino acids) is a crucial point to emphasise; as a result, the foods that contain these proteins cannot be considered suitable alternatives for meat because of their poor nutritional profiles.

## 1.2 Current positioning of plant based foods in the food market

A recent Teagasc conference provided attendees with an up-to-date report on Irish companies' involvement in the increasingly profitable plant-based food industry. The sales of plant-based foods in Europe had a total €3.6 billion in the year 2020. The sales of plant-based products were found to be greatest in Germany, followed by the UK (Cadogan, 2022). According to the presenters at the conference, the Nestlé

corporation alone generated sales of €780 million worth of vegetarian or plant-based goods in 2021. It is projected that sales of meat alternatives generate €1.4 billion annually, with the majority of these products taking the shape of imitation "sausages," "burger patties," and "cold cuts" (Cadogan, 2022).

These tendencies were consistent with the results that the "association" with vegan and vegetarian diets is growing, notwithstanding the small percentage of people who adhere to these lifestyles (only 2% in Ireland and the UK for vegan, but 8-9% had vegetarian lifestyles). The percentage of people in Ireland and the UK who identify as "flexitarians," or those who eat meat and fish on occasion but follow a vegetarian diet most of the time, was estimated to be 16%.

For many people who had altered their diets, the cost was the primary barrier where 18% of individuals who gave up vegan or vegetarian lifestyles reporting they did so because it was too costly (Cadogan, 2022).

The production of imitation meat from plant-based sources of protein that contain a wider range of amino acids may be accomplished by processing soy, quinoa, chia, and hemp. Hemp, coffee flour, peas, chia seeds, and flax seeds are some more foods that are rich in protein content. These products provide a sufficient quantity of the vast majority of necessary amino acids and will soon be a staple in the diet of the typical consumer (Mistry et al., 2020).

Although Plant-Based Meat Alternatives (PBMAs) have been on the market for decades, they've seen a recent resurgence in popularity within the food industry, which has led to a progressive increase in product options found on supermarket shelves. This is in part due to increased consumer and industry awareness of climate change and food sustainability needs, the search for healthier options, and the rising number of vegetarians, vegans, and flexitarians. For instance, in the UK vegans represent 2-3% and while vegetarians represent 5-7% of the population (Prescott-Smith & Smith, 2022).

Over 500,000 people in the UK have recently adopted a lifestyle diet that substitutes plant derivatives for conventional animal sources. Between 2014 and 2019, the vegan population has increased by four times. The food business is responding by making more meat alternatives as this popularity grows internationally. The term "vegan" has

typically been connected to advantages for human health. Marketing for such products has tried to establish the perspective that all plant-based meat alternatives are sustainable and nutritious for the consumers' health (Gallagher, et al., 2022).

Since the 1960s, the first PBMA products have been available for purchase, and the topic of PBMAs has gradually become more prevalent in the food sector. These items are being stocked in ever-greater quantities in local supermarkets. It's possible that increased consumer knowledge is to blame, along with the growing population of vegetarians, vegans, and flexitarians (He et al., 2020). Studies on the subject have also increased, Figure 1.1 shows number of article publications of PBMAs from 1960 to 2019.

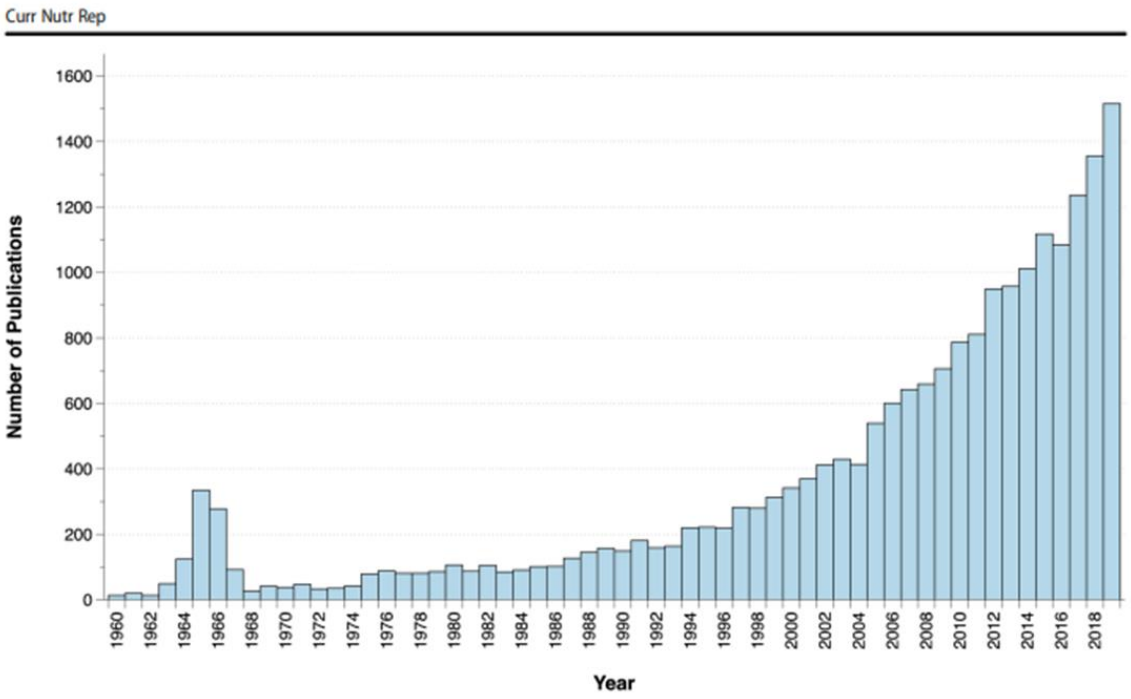



**Fig. 1** A PubMed search using the following terms "meat substitutes" or "meat alternatives" or "meat analogues" or "meat analogs" or "meat surrogates" or "fake meat" or "faux meat" or "mock meat" or "imitation meat" or "plant-based meat alternatives" or "cultured meat" or "clean meat" or "cell-based meat" or "lab-grown meat" or "in-vitro meat" or "insect-based protein" or "Beyond meats" or "Beyond burger" or "Impossible foods" or "Impossible burger" or "Mosa meat" or "Memphis meats" or "Quorn meat" or "mycoprotein" yielded 18,781 articles from 1960 to 2019

**Figure 1.1** - Number of publications from 1960 to 2019 of protein for meat alternatives (Taken from Thavamani, et al.,2020)

A study in PBMAs popularity conducted during 2008–2019 shows that the consumption of PBMAs in the UK has increased dramatically**.** This is despite the fact that PBMAs consumption still accounts for a very modest fraction of daily dietary energy intake. The study also shows that the consumption of PBMAs is greater among females, millennials (i.e. persons aged 24–39 years), and those in the highest income brackets. This suggests that different socioeconomic groups face distinct obstacles when trying to get access to PBMAs. The study findings suggest that individuals who consume less meat also have a higher reported consumption of plant-based food groups such as PBMAs and other plant-based food groups. This provides support to the hypothesis that these products play a role in the progression of diets in the UK away from animal products (Alae-Carew et al., 2022).

### 1.3 Current positioning of Traditional Meat Products in the food market

In 2018, the total amount of bovine meat produced in Ireland accounted for 14 percent of the total amount of bovine meat produced in the EU-28. The total amount of meat processed in Ireland accounted for five percent of the total amount of meat produced in the EU. In 2018, exports of beef, sheep, and pig-meat totalled nearly €3.5 billion, with beef exports accounting for around €2.3 billion, pig-meat exports for €890 million, and sheep-meat exports accounting for €318 million. (ICTU, 2022).

According to an evaluation revised by Power of the Irish beef business for the Irish Farmers' Association (IFA) in March 2020, said that it appears that considerable earnings are generated by the amount of throughput rather than by broad margins. (Power, 2020).

The Irish market suffered increases in turnover and in employment that have occurred in the meat processing sector over the course of the past decade have been accompanied by low levels of investment, low levels of value-added, and low levels of wages, in addition to what appears to be declining levels of profits over the course of recent years. It is abundantly clear that the very substantial public funding and support upon which this model is based comes with very few conditions relating to the promotion of decent work, social dialogue, and collective bargaining, as well as the combating of social externalities such as low pay, precarious work, and poor social benefits. A basic issue with this model is that it was becoming less and less feasible even on its own terms before the pandemic hit. This is in addition to what this

entails for employees in the industry, which is now being brought to light by Covid-19. This is a fundamental problem with this model. According to the findings of a research conducted in 2017 for the Agriculture Committee of the European Parliament, the EU cattle industry has been confronted with a number of "serious problems" in recent years. These include fluctuations in prices, issues with profitability, shifting demand in terms of both quantity and quality, higher levels of competition, shifting geopolitical contexts, fluctuating international economic conditions, and the effects of climate change (European Parliament, 2017).

In addition, a report that was published by the European Commission in December 2019 predicted that over the course of the next decade, EU meat consumption is projected to fall modestly, driven by social, ethical, health, and environmental considerations. The report also stated that "ample supplies from Brazil, the United States, and Argentina will continue to put downward pressure on world and EU beef prices in the coming years" (European Commission, 2019).

### 1.4 PBMAs Brands available in Ireland

Irish supermarkets stock a good range of PBMAs. Table 1.1 shows some of the brands available in the country.

| **Brands** | **Product range** |
|---|---|
| Plant Chef | Plant based range from Tesco |
| Plant Kitchen | Plant based range at Marks & Spencer's |
| Plant Menu | Plant based range from Aldi |
| Plant to Plate | Plant based range from Lidl |
| The Veg Kitchen | Plant based range from Supervalu |
| Wicked Kitchen | At Tesco – includes selection of vegan ready meals |
| Beyond Meat | Burgers, sausages, etc. |
| Clive's Pies | Meat free chickeny puff pie |
| Fry's | Burgers, sausages, meat substitutes, etc. |

| | |
|---|---|
| Glas | Range of vegan burgers, company based in Offaly |
| Gosh | Burgers, bites, and sausages |
| Mighty Mushroom | Range of vegan burgers, sausages and mince |
| Naturli | Mince and burger patties |
| No Bull | Large range of vegan frozen products exclusive to Iceland supermarkets – chicken, burgers, paella, chorizo, sausages, etc. |
| Oumph | large range of PBMAs products |
| Pimp My Salad | Coconut bacon |
| Vivera | Range of meat substitutes – burgers, steak, kebab strips, etc. |
| Pant It | Range of burgers and other products, made in Ireland. |
| Plantruption | Seaweed burgers and other products, made in Ireland. |
| Sons of Butchers | Irish company – burgers, sausages, etc. |
| Squeaky Bean | kievs, fishless fingers, nuggets |
| Strong Roots | Irish-based company – variety of vegan burgers, vegetables and frozen food products. |
| Taifun | Tofu sausages, slice, etc. |
| Thanks Plants | Vegan roasts and sausages – made in Dublin |
| The Meatless Farm Co | Sausages, burgers and mince |
| The Tofoo Co | Range of tofu products and sausages |
| The Vegilantes | Hand made PBMAs such as Jackfruit burgers,Ch*cken popcorn,Ste*ks, Ch*cken Satays, etc |
| Tofurky | Large selection of slices, sausages and other fake meat products |
| Uptons Naturals | Jackfruit, seitan, curries, burgers and other products |
| V-Bites | Sausages, roasts and many other meat substitutes |
| Vegafit | Burgers, steaks, nuggets, schnitzels, etc. |

| | |
|---|---|
| What the Faux Plant-based Creations | vegan steak, ribs, etc. – made in Dublin |

**Table 1.1 -** List of PBMAs brands available in Ireland (taken from The Irish Vegan,2022).

### 1.5 PBMAs Brands and Ingredients

The following paragraphs shows four brands that can be found in Ireland and gives a brief description on the brands' products and ingredients used to produce them.

Beyond Meat: Offers Plant-based Burgers (see picture 1), Mince, Meatballs and Sausages. The Beyond Burger and Beyond Mince have the following components; peas, brown rice , rapeseed oil, coconut oil, potato starch, methylcellulose (plant fibre derivative), beet juice and apple extract.(Beyond Meat, 2022).

Oumph: Products are inspired by the big flavours of the world using mainly TVP (Textured soya bean products) in their range. Oumph's Sticky Smokehouse Rib Style (see picture 2) for instance uses, TVP, tomato, beet syrup, spices, vinegar, apple juice concentrate, and xanthan gum. (Oumph, 2022).

Fry's: Offers a range of meat substitutes including Chicken-Style Nuggets (see picture 3), Soy & Flaxseed Schnitzels, Fish-Style Fillets, Chicken-Style Strips. The ingredients used in their products are: Soybeans, Wheat, Rice, Quinoa, Chia Seeds, Sunflower Oil, Coconut Oil, Flaxseed Oil, Palm Oil, Potato Starch, Maize Starch, Methyl Cellulose (as thickener agent), Mustard, Tomatoes, Garlic & Onion, Colourants and Flavour Enhancers. (Fry Family Food, 2022).

Plantruption: Offers burgers (see picture 4) made from a blend of dried red, brown, and green seaweeds that are certified to have been organically harvested, combined with a wholesome mix of protein-rich tempeh, vegetables, and spices (Plantruption, 2022).


**Figure 1.2 -** Beyond Burger packaging (2022**)**


**Figure 1.3 -** Oumph packaging (2022)


**Figure 1.4 -** Fry's packaging (2022)


**Figure 1.5 -** Plantruption Burger packaging (2022)

### 1.6 Sources of plant-based meat alternatives and their process

Table 1.2 shows the primary sources of plant proteins that are used in the production of meat substitutes:

| Plant source | Protein types | Used in |
|---|---|---|
| Wheat | Gluten (Gliadins, and Glutenins) | Impossible burger |
| Filamentous fungus (*Fusarium venenatum*) | Mycoprotein | Quorn |
| Legumes | Legumin and Vicilin | Meatless uses lupine and several other brands use the legume soybean |
| Oil seeds | Albumins, Globulins, and Glutelins | Products made from the seed cake of oilseeds such as hemp and flax |
| Rice | Glutenin, globulin, albumin, prolamin | Bahama Rice Burger that uses Risofu |
| Pea (*Pisum sativum var macrocarpon*) | Pisumin, Legumin, vicilin, albumins | Burgers and other analogues made by Beyond meat Inc. |

**Table 1.2 -** Plant protein sources and their use in meat analogue preparation (taken from Mistry, et al., 2020)

### 1.6.1 Wheat (Seitan)

Wheat gluten, popularly known as Seitan, is an essential protein for many vegan and vegetarian diets. The protein is produced by using a mixture of wheat proteins, such as glutenin and gliadin, in the manufacturing process. Because of the high concentration of protein in seitan, it makes an excellent meat substitute due to its elastic and fibrous properties. The flavour is mild and neutral. As a result, it is possible for it to take on the flavours and spices of other substances that were added during the manufacturing process. The traditional method for making seitan involves mixing water and flour to form a dough. The dough is then washed numerous times until all of the starch is removed, at which point the dough assumes the form of a fibrous, meat-like mass. At an industrial scale, the preparation of seitan is carried out in a manner that is notably distinct from its domestic counterpart. Specifically, a wheat gluten powder is mixed with water and kneaded to create a dough. After that, this dough is subjected to pressure and cooked for an hour in water. To impart flavour into the dough, it is typical to use flavourings such as soy sauce, nutritional yeast, mushroom powder, or other marinades. Seitan may be prepared in a variety of forms that resemble processed meat, including deli meat, strips, chunks, and other similar items (Mistry, *et al*.,2020)

### 1.6.2 TVP (Textured soya bean products)

TVP is one of the oldest plant-protein based products that have been available on the market; it was first produced by Archer Daniels Midland in the 1960s. TVP is a kind of vegan meat that goes through a significant amount of processing. It is manufactured from soy flour, which is a by-product of the manufacturing of soy oil, and the fat is removed using solvents. This ends up producing a product that is low in fat and rich in protein. This soy flour has the capability of being extruded into a variety of pieces, nuggets, forms, and granules. It has a convenient storage method, a long shelf life, a nice texture, a high protein content, a reasonable cost, and a low amount of saturated fat. Unfortunately, neither the flavour nor the odour live up to expectations in any way.(Mistry, *et al*.,2020)

### 1.6.3 Mycoproteins

Mushrooms are a potential source for mycoproteins to be extracted. A well-known brand known as "Quorn" manufactures items that may be purchased in the form of meat substitutes such as steak, chicken cubes, mincemeat, and sausages. Fusarium venenatum strain PTA-2684 is the microfungus that is used in the production of Quorn. The product is manufactured in a fermentation chamber, which is also where the components that boost the food's nutritional value are added. After the fermentation process is complete, the mixture is dried, and for the non-vegan alternative, egg albumen is added. This step is critical because it enables the desired shapes to be created, such as steaks, burger patties, chicken-style bits, or sausages. In place of egg albumen, the potato protein is used to bond the ingredients in the vegan version.(Mistry, *et al*.,2020)

### 1.6.4 Jackfruit

Jackfruit, which has a consistency that is similar to that of pulled pork, has seen a surge in popularity over the last several years. Although it is extremely low in calories and rich in fibre and potassium, its supply of protein is rather low (one cup of jackfruit offers 2.4 grammes of protein). However, it is a very good source of fibre. (Thavamani, *et al.*,2020).

### 1.6.5 Pea Protein

Pea protein is the most promising for the use of meat analogues because of its low allergy, high nutritional value, and strong emulsion and foam stability abilities. Pea Proteins also have a lower potential for gelling, and structures made from pea-based goods are noticeably less elastic and noticeably softer than those made from soy-based products. It is important to point out that while plant proteins are generally considered to be excellent sources of protein, the majority of them are missing one or more of the necessary amino acids. Therefore, the use of extra protein sources, such as whey proteins and egg whites, is strongly urged in the development of meat substitutes, both for reasons related to nutrition and those related to functionality (Sun, et al., 2021).

The first stage in making use of pea proteins is to extract and/or separate them from their respective mixtures. In the past, isolating plant proteins required a wet separation process, which consisted of a series of unit operations such as aqueous extraction, centrifugation, isoelectric precipitation, washing, neutralisation, and drying . These unit operations were followed by drying the isolated plant proteins. Wet separation has the potential to produce an isolate of protein that is relatively pure, but it comes at a considerable cost in terms of water, chemicals, and energy. Dry separation is a type of extraction that has seen fast development in recent years as a process that is better for the environment. Dry separation is a part of the general operation process, and it comprises solely physical and mechanical biomass size reduction, such as ultrafine milling, as well as methods for the separation of biomass, such as air classification and/or electrostatic separation. This method has been used successfully to produce protein concentrate from a wide variety of legumes and pulses, including field peas, northern beans, fava beans, lima beans, mung beans, lentils, and so on. The low energy consumption level, the avoidance of the use of chemicals, and the ability to be applied in areas where water resources are limited all contribute to the method's success (Zhu, et al., 2021).

## 1.7 General Process

In the food sector, several processing procedures have been developed with the goal of replicating restructured alternatives or other whole-muscle equivalents. Some of these approaches include: Electrospinning, thermo-extrusion, conical shear, and wet spinning are only some of the manufacturing processes that may be employed to create meat substitutes (Sha & Xiong, 2020).

In wet spinning, fibres are produced in a spinneret, which spins a liquid protein solution at a certain pH to produce fibres. These fibres are then spun into yarn. Electrospinning is the use of mechanical elongation and the precipitation of anti-solvent in order to generate filament networks from zein. Thermo-extrusion, on the other hand, is not only the least expensive but also the most effective and highly prolific production method. Plant proteins may be transformed into structures or shapes resembling fibrils by the use of thermo-extrusion. The extruder makes use of a device that is able to create drag flow in order to provide the necessary pumping action, and this device may either be a single spinning screw or a pair of rotating screws. The barrel and the melt interact with one another in a process called single-screw extrusion, which generates friction. On the other hand, when using twin screws, the product is transmitted in huge quantities between the screws, which results in more effective forward conveying. Thermo-extrusion may be broken down into three distinct categories: high-moisture extrusion, intermediate-moisture extrusion, and low-moisture extrusion (Sha & Xiong, 2020).

The procedure is shown in the following figure1:

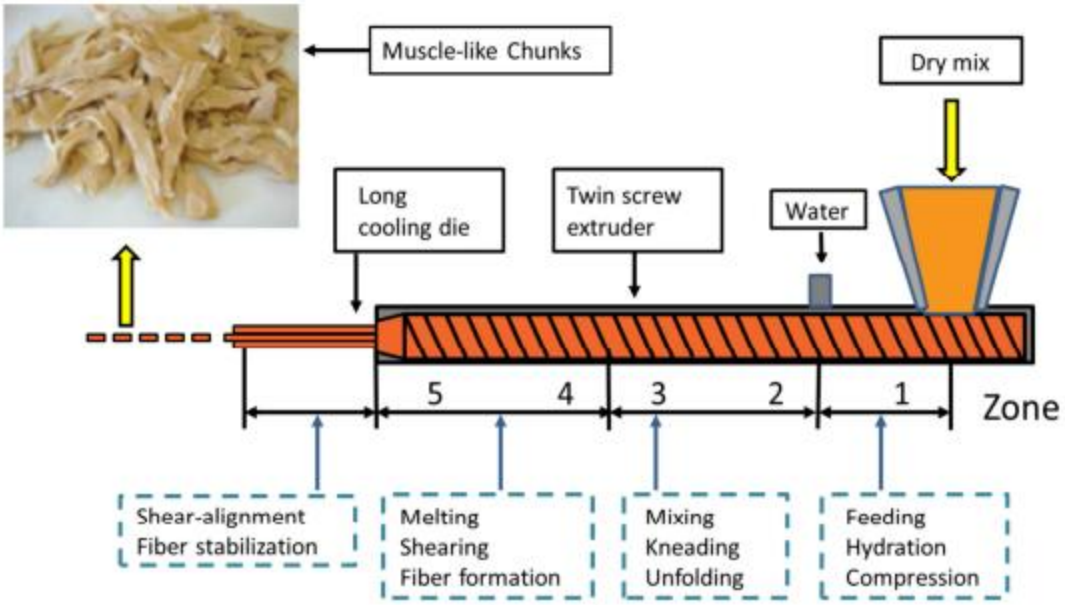



**Figure 1.6 -** Extrusion of a material with a high moisture content using a twin-screw extruder (taken from Sha and Xiong, 2020).

## 1.8 Production of Traditional Meat products

### 1.8.1 Beef Burger Production

According to Meat-Machinery (2022) when it comes to preparing patties, the most common kind of meat to use is ground beef. The vast majority of hamburger patties sold in grocery stores and chains of fast food restaurants are prepared from beef trimmings that have been ground up with additional fat and by-products. There are three basic categories of by-products, which are as follows:

- The muscle under animals' skin
- After the primal cut has been obtained, the scraps of flesh and sinew that are left behind from animal bones are collected.
- The scraps that are removed from the neck bones and the remaining meat.
- The fatty tissue extracted from the animal's body.

After the raw beef has been delivered to the processing facility, the working people conduct an inspection of the beef to verify that it does not include any foreign objects or bones that are visible, and that it does not have an unpleasant odour. A standard test

to determine the presence of germs is required for raw meat, and a sample of the beef may be collected to determine the proportion of lean to fat in the meat. It is standard practise to continue to keep the beef at the same level of refrigeration that it was in when it was delivered. This is done so that it may be ground according to the FIFO (Fist-In-Fist-Out) rotational system. (Meat-Machinery, 2022).

After the first coarse grinding, the beef is put into a meat blender, which is where the raw ingredients for manufacturing patties are combined and blended. The goal of the initial coarse grinding is to generate a product that is described as "coarse ground." During this step of the process, various additives, including as salt, seasoning, binders, extenders, vegetable protein products, water, and so on, may be added, and the mixture or blend that follows will guarantee that all of the components are distributed in a manner that is uniform and consistent. Following the steps of mixing and blending, the beef is ground for a second time to produce a product with a finer consistency. Following the completion of the final grinding process, the product is then sent to beef patty manufacturing and shaping machines, which shape the product into patties according to predetermined parameters for the patties' thickness, size, and weight (Meat-Machinery, 2022).

After it has been shaped, the product, if it is to be frozen, travels through one of three different freezing systems: a blast freezing system, a mechanical freezing system, or a cryogenic freezing system. The product is then packaged in order to achieve the highest possible quality (Meat-Machinery, 2022).

### 1.8.2 Chicken Tenders and Nuggets Production

The method of making chicken tenders and nuggets begins with the use of boneless chicken (breast, rib meat, tenderloin, and skin), which goes through a step named "Meat Muscle Formulation" before being moulded, breaded, fried, and frozen. For items with higher particle sizes, the equipment includes meat grinders, while bowl choppers or comminutors are used for products with considerably lower particle sizes. A Twenty percent weight addition of skin to the meat block provides weight at a low

cost, but it also has some binding capability and enhances taste mostly via its lipid component. Other ingredients may be added for functional reasons. By removing myofibrillar proteins from the muscle, salt works as a binding promoter and taste enhancer. Gums provide binding ability and may improve texture, corn-starch promotes binding, sugars offer colour and taste, sugars add flavour and nutritional value, and soy proteins give flavour and nutritional value to formulations. Depending on the requirements for the product, spices and flavouring agents may be added at this point. A typical addition is salt, along with other peppers, vinegars, fruit and vegetable juices, and extracts (such as lemon juice). Typically, ingredients are combined with the meat block (bulk, decreased particle-size raw meat) in a ribbon blender. If marinade is added, the blender may be used under vacuum and offers excellent mixing control. Some of these blenders may additionally have two walls to provide cooling capacity to the meat block to regulate temperature (Smith, 2014).

**Moulding:**

Forming machines are used in processing. The meat mixture is pressure-pressed into moulds and stamped out onto a conveyor belt for further processing after the meat block is fed to the machine's hopper in bulk (breading, glazing, etc.). Moulds may be designed for general markets, such as stars or dinosaur shapes for kids, or they can be plain circular nugget or patty sized and filled with batter. Other moulds, which are filled with bigger pieces of meat to create a higher-value product, resemble whole-muscle fillets or delicate forms (Smith, 2014).

**Coating:**

Batter and breading may be the most common chicken coating method. The fundamental procedure involves three steps: the placement of formed components in a dry predust, a wet batter coating, and a final dry breading. The components employed in these coatings vary in an incredibly wide range; grain kinds (although they are often maize or wheat based), salt and other spice concentrations, colour additives, and particle size all affect how the end product turns out. A continuous stainless steel wire

conveyor line is used by equipment to apply bread coatings to transport goods through the system. The wire conveyor also pushes the product through a bed of predust to coat the bottom. The preduster is filled with the dry mix and sifts or falls onto the product from above. The product then enters the batter machine covered in a puddle of batter; certain machines may additionally cascade batter onto the object from above. In order to thicken the batter for better pick-up and to lengthen the shelf life of the recirculated liquid, a dry mix is blended with water at the machine and is normally chilled (Smith, 2014).

**Heating systems**

To keep the product moving while it is being heated, ovens and fryers are designed to be used for in-line processing. Fryers may be used to either par-fry or completely cook chicken. When par-frying, leave battered or breaded foods for 30-60 seconds to allow the coating adherence and colour to solidify. The amount of fully cooked food depends on the product's size and nature. Most items are no longer completely cooked in fryers owing to poor yield as fluid escapes, health-conscious customers demanding lower fat products, and drastically deteriorated oil quality as a result of the extended dwell and leaking fluids and breading crumbs or fines. Product is pulled along the fryer bed by stainless steel wire belting. Items floating in the oil are pushed along and out of the fryer using an overhead belt that moves at the same speed as the bottom belt. The heated oil is cycled, filtered to remove crumbs and particles, and reused until the quality deteriorates. The oil eventually becomes useless due to the build-up of free fatty acids and oxidation products. The temperature of the frying oil is continuously regulated to maintain product cooking at a temperature lower than the oil's flashpoint and prolong the oil's life. Between an entering product and a freezer is where the standard in-line oven cooking system is located. By mixing or alternating dry and wet heat as the product goes through the oven and using fans for convection heating, special batter and breaded coating systems may be cooked in an oven without a fryer. The wire conveyor in a spiral oven spirals upward, making it another kind. This layout encourages a reduced carbon footprint within the facility and uses less energy to heat the product (Smith, 2014).

**Freezing:**

There are several choices when freezing. Product is moved by forced cold air contact at minus 37.2 C in tunnel freezers with conveyors. Older models that are still in use inject carbon dioxide into the tunnel to make pellets or powder that directly touch the product and quickly freeze it (Smith, 2014).

**Packaging:**

On the production line, processed and further processed products are first packaged into primary packaging, and then into secondary containers. There are many varieties of packets, innumerable even. Foam trays with plastic overwrap, plastic bags, resealable pouches, shrink-wrapped bags, and paper cartons are examples of basic kinds (Smith, 2014).

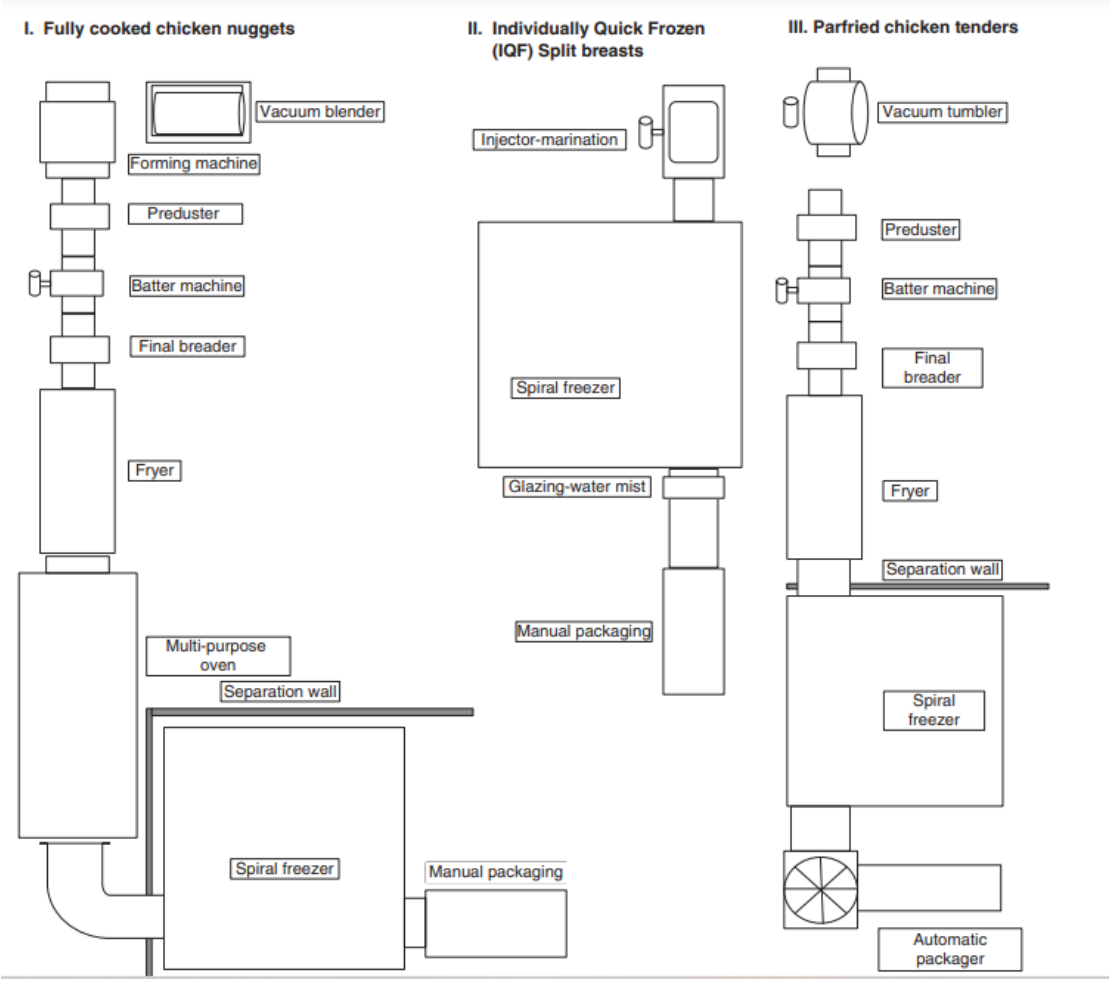



**Figure 1.7 -** Examples of processing lines for processed chicken products (taken from Smith, 2014).

### 1.8.3 Sausage Manufacturing

The processing of meat into sausage was at first developed as a method for preserving and transporting meat. There are about 250 different kinds, and a significant number of them may be traced back to their respective countries of origin. Because they are convenient to include in meals that can be prepared in a short amount of time, sausages now play an important part in modern culture. In addition, due to the additional effects of salt, pH, curing, drying, and cooking on the preservation of the product, sausages are a product that can be consumed safely. (Meat-Machinery, 2022).

It may be made with beef, veal, hog, lamb, chicken, or any mix of these meats. There are many different kinds. The manufacturing of sausage has evolved into a process that combines old methods and new scientific and highly mechanised methods. The following are the primary steps involved in the production of sausages:

- Choosing the constituent parts
- Grinding meat ingredients
- Combining the meat with the non-meat components in a blender.
- Stuffing and filling
- Smoking
- Packaging and storage

**Choosing the constituents parts**

Using components of a high grade is the most significant phase in the process of manufacturing sausages. It is important that the meat be fresh, of excellent quality, and have the right proportion of lean to fat, this provides strong binding characteristics. It is necessary for the meat to be risk-free for production. It is essential to choose the appropriate spices and flavours and to combine them in the right proportions. The process of creating sausage requires the use of non-meat components. The combination is made more stable by the addition of these non-meat ingredients, which also provide certain qualities and flavours to the finished product. A variety of traditional spices, seasonings, and flavourings are used in addition to water, salt, and antioxidants in the preparation process (Meat-machinery.com, 2022).

**Grinding meat ingredients**

The grinding of the components in an effective manner using a meat grinder is the second stage in the manufacture of sausage. During the grinding step, the meat component is broken down into very small particles that are all the same size. The majority of sausage recipes call for ground meat as their foundational component. The features of the meat components that are used to form the sausage, such as its overall flavour, texture, and scent, as well as the amount of protein and fat included in the sausage, this determines the kind of sausage. In most cases, the grinding process will change according on the manufacturer as well as the kind of product being processed. Some sausage products employ components made from coarsely ground meats, while

others use ingredients made from more finely ground meats. Some producers crush the lean meat, and fat trimmings in separate mills to get their desired consistency.

**Combining the meat with the non-meat components in a blender**

In order to get the desired texture and flavour profile in a particular sausage formulation, manufacturers exert a great deal of control on the mixing of the meat and non-meat elements. The meat and non-meat ingredients are mixed together well in a meat mixer after being put in the blender. In addition to this, the blending procedure has to ensure that the final formulation contains an evenly distributed amount of any non-meat elements. To take one example, all of the seasonings, salts, and other components of a sausage formulation need to be thoroughly and uniformly combined

.

**Stuffing and filling**

After the blending process is finished, the combined materials may be packaged in bulk or extruded into a casing, depending on the preference. The term "stuffing" refers to this technique. In addition, the sausage stuffer machine is an essential piece of equipment for filling any kind of sausage.

**Smoking**

The smoking procedure is used to certain of the sausages. This phase varies according on the kind of sausage being made. The meat is smoked in order to dry it out and cure it, as well as to introduce flavours and aromas onto the finished product. A smoke generator produces natural smoke by burning hardwood sawdust, wood chips, or logs in an environment that is carefully monitored and managed. However, automated meat smocking machines have largely taken the role of conventional smoking machines. These machines use an enhanced smoking approach to treat meat in a manner that is both more hygienic and less hazardous to one's health than the previous smoking method.

**Packaging and storage**

The newly made sausage is packaged in a manner that is appropriate for its category. A gas-impermeable material might be wrapped around the product, or it could be

vacuum-packed. Finally, the finished product is put into cold storage before being sent out to customers.

### 1.9 Meat an unique flavour

Meat is still the preferable choice in the western diet. Even with new meat alternatives that have just joined the market and are easy to get, it is still difficult to win over customers who like meat products. The animal's diet is responsible for giving its peculiar flavour, which has been likened to a metallic quality in certain cases. The breakdown of food sources including grain, vegetables, and grass is necessary for the production of the animal cell wall structure that is present in all living things. Cooking causes the destruction of enzymatic cells, which in turn triggers a series of bioreactions involving sugar, fatty acids, and amino acids. These procedures are what end up imparting flavour and aroma to the meal in the end. It is generally agreed upon that the molecule known as myoglobin, which is responsible for transporting oxygen throughout the muscle cells, is one of the most important contributions to the flavour of meat. Myoglobin loses its original structure when it is cooked, which triggers the release of heme. Heme is responsible for the flavour and aroma of cooked meat. When meat is cooked, the colour of the flesh changes because of the oxidation of the iron molecules that are located inside the myoglobin. According to Pat Brown, the founder of Impossible Foods, in order to make a meat replacement that is flavourful like meat, it is feasible that all of these responses will play a role in imitating a product with comparable taste. Brown claims that this is the only way to create a product that is comparable to the flavour of meat. Therefore, the heme molecule is the most important contributor to the one-of-a-kind flavour that the flesh has. This conclusion may be drawn from the following: Plants of the genus Legae are responsible for the production of leghaemoglobin, a molecule that contains heme. Myoglobin is an essential component of animal muscles, although it can only be found in animal muscle cells. It is now possible for plant burgers to recreate the sizzle and juices of typical beef patties when they are grilled on a barbeque. However, the chemical heme would have to be added to each and every alternative to meat that was being considered. Unfortunately, the roots of legumes only contain a minute quantity

of heme; hence, it would be required to employ an amount that is unsustainable in order to create a very tiny quantity of the product that is needed. This would be an undesirable outcome. Impossible Foods was effective in manufacturing heme within the confines of a laboratory environment. It is feasible to produce it in big amounts by first separating the genetic code from rhizobia, which is a kind of bacteria that is found in soybean root, and then injecting that code into yeast. This process may be repeated as many times as necessary to produce the desired amount. by creating the circumstances essential for their development and the generation of a significant quantity of heme, we may help them. After that, this mixture is put through a filter, which separates the yeast, water, and concentrated heme into their respective components. This may be used in the production of plant burgers that make use of wheat protein. These plant burgers not only have a higher total amount of protein and nutrients when compared to a standard beef burger, but they also have a much lower total amount of saturated fat. Utilising scientific methods in the manufacturing of chicken, fish, bacon, and dairy products are some of the responsibilities that fall within the purview of the company's research and development division (Mistry, *et al*.,2020).

### 1.10 Consumer view on Plant-based Alternatives and Meat products

A study conducted in 2020 on “Consumers’ associations, perceptions and acceptance of meat and plant based meat alternatives” with the objective of determining the obstacles that prevent people from consuming meat alternatives and increasing the likelihood that they will consume them in the future. (Michael, et al.,2020).

The study was performed by investigating the free connections that individuals have towards meat and meat substitutes, comparing chosen meat items with their corresponding meat replacements using an online survey that included 1039 participants. The individuals expressed positive feelings towards meat, but they had negative feelings toward PBMAs. It is likely that meat eaters have had unfavourable encounters with vegans or vegetarians who refused provided food or demanded special treatment in addition to moralising about meat eaters. This might be one reason for the usually negative attitude of meat substitutes. Their unfavourable opinions about PBMAs may have been strengthened as a result of the fact that they were connected with vegetarianism and veganism. In addition, we discovered that the

correlations between females and males were different when it came to meat, but not when it came to PBMAs. While females reported being concerned about animal welfare and the environment and stated that they consumed a modest amount of meat, males thought about the good features of meat such as flavour and diversity. This hesitation that females show about meat is most likely due to the increased understanding of the detrimental consequences of eating meat. This helps to explain why females eat less meat than males do and why they are more inclined to adopt a vegetarian diet.(Michael, et al.,2020).

While most modern meat substitutes are made from mycoprotein, peas, or wheat, several of the participants cited tofu and soy as being associated with meat replacements. When we looked at the frequency of consumption of meat and meat alternatives, we find that the average flexitarian reported consuming slightly less than four portions of plant-based protein and almost five portions of meat per week, while the average omnivore reported consuming between one and two portions of plant-based protein and more than nine portions of animal protein in the form of meat alone, suggesting that their meat consumption is generally low (Michel, et al., 2021).

In order to encourage people to consume meat substitutes rather than actual meat. The acceptability of meat substitutes was studied, along with a number of elements that influence that acceptance. It has been shown that the context in which meat substitutes are consumed has an effect on the degree to which people are willing to use them as a substitute for real meat. For instance if one is dining by oneself PBMAs received the greatest acceptability ratings, the propriety of eating PBMAs with the family on a Sunday was questioned. This indicates that individuals may not want to draw attention or may be fearful of being evaluated by the choices they make about their meals when they are in more formal settings or conditions where a certain amount of peer pressure is likely to be present (Michael, et al.,2020).

### 1.11 Sustainability

There is a clear relationship between the increase in the world population and the desire for more meat. The demand for beef has increased by roughly 60%during the past two decades. It is anticipated that the market will expand by 15% by 2027. (He, et al., 2020). Unfortunately, rising demand also has significant environmental consequences, by increasing greenhouse gas emissions, and water and land use to

support meat production, which contributes to global warming (Thavamani, et al.,2020).

As it is right now, the food industry is accountable for anywhere from 25 to 30 percent of the world's total greenhouse gas emissions. Specifically, animal-based protein is an issue due to the high livestock numbers that are causing water depletion, contributing to the acceleration of climate change, producing disruptions in the phosphorus cycle, and having unfavourable effects on biodiversity and the nitrogen cycle. The negative effects of livestock production are not limited to the environment; rather, they have an immediate and direct influence not just on human health but also on the wellbeing of animals. The ever-increasing demand for meat and dairy products presents a number of formidable obstacles. In order to meet this need, western nations will need to make a transition toward consuming less meat and dairy. One strategy for accomplishing this goal is to replace meat with alternate protein sources. In recent years, several different forms of meat substitutes that use insects, egg whites, grains, pulses, or fungus as a source of protein have reached the market, and the introduction of cultured meat to the market is on the verge of happening. The growth in worries about animal suffering and the development in vegetarian and vegan lifestyles have undoubtedly contributed to an increase in the market for meat substitutes; yet, in the majority of European nations, meat replacements are still considered to be specialty items. More information is required in order to promote a diet that is more sustainable by using meat substitutes as a source of protein instead of meat. This information should include potential obstacles, expectations, and opportunities for the items in question (Michael, et al.,2020).

In order to arrive at a scientific consensus regarding what constitutes a diet that is both healthy and environmentally friendly, the Food, Planet, and Health committee (ETA-Lancet) gathered together more than thirty of the most recognised scientists from all over the world. A paper was created by the ETA-Lancet on how to feed 10 billion people by the year 2050. The research includes nutritious and sustainable advice for a sustainable diet and dinner. According to research published in Lancet, the current daily consumption of vegetables in Europe averages 150g per person. The recommended amount of 300gshould ideally be broken up into three servings of 100g each and comprised of a wide variety of vegetables of different colours (Willett, et al.,2019).

Willet also mentions that the production of beef is responsible for 15–24%of all carbon emissions, primarily in the form of methane. This makes the production of beef the primary contributor to the greenhouse effect. It also makes significant use of both land and freshwater resources. This usage of land also results in the destruction of forests, which has a direct and detrimental influence on biodiversity.

Meat is unique among foods in that it not only satisfies human desire but also satisfies a wide variety of nutritional needs. This is especially true when compared to other types of foods. Due to the rapid increase in the number of people living in the world, the demand for meat is skyrocketing. It is anticipated that there will be an increase in demand between 75-80%during the next thirty years.

### 1.12 Nutrition aspects

While nutrition has been previously investigated in these products, this research will further investigate the nutritional content of meat analogues in comparison with conventional meats, focussing on health factors such as the reduction in HFSSs (high fat, salt and sugars) seen in products recently adopted by some European countries. This research has the main objective to unveil consumers' perceptions on PBMAs against Traditional Meat Products, it will also briefly evaluate and rank products based on their overall nutrition, level of processing, and sustainability.

For this research, a tasting panel and a survey will be used to collate data on consumer preferences and perceptions between meat and plant-based meat alternatives. A tasting panel will happen at  The Culinary Food Group by using the Development Kitchen and The Sensory Room, where tasting is often carried out by myself (Development chef and sensory lead). The R&D kitchen will provide health and safety procedures ensuring all products are safe for consumption.

## 1.13 Research Question

The Survey and Tasting Session strategy planned to use in this study will provide the data needed to answer the research question:

Are Plant-Based Meat Alternatives (PBMAs) a better choice? Comparing the sustainability, processing, consumer view, and health factors of PBMAs against animal origin products?

## 1.14 Aims & Objectives

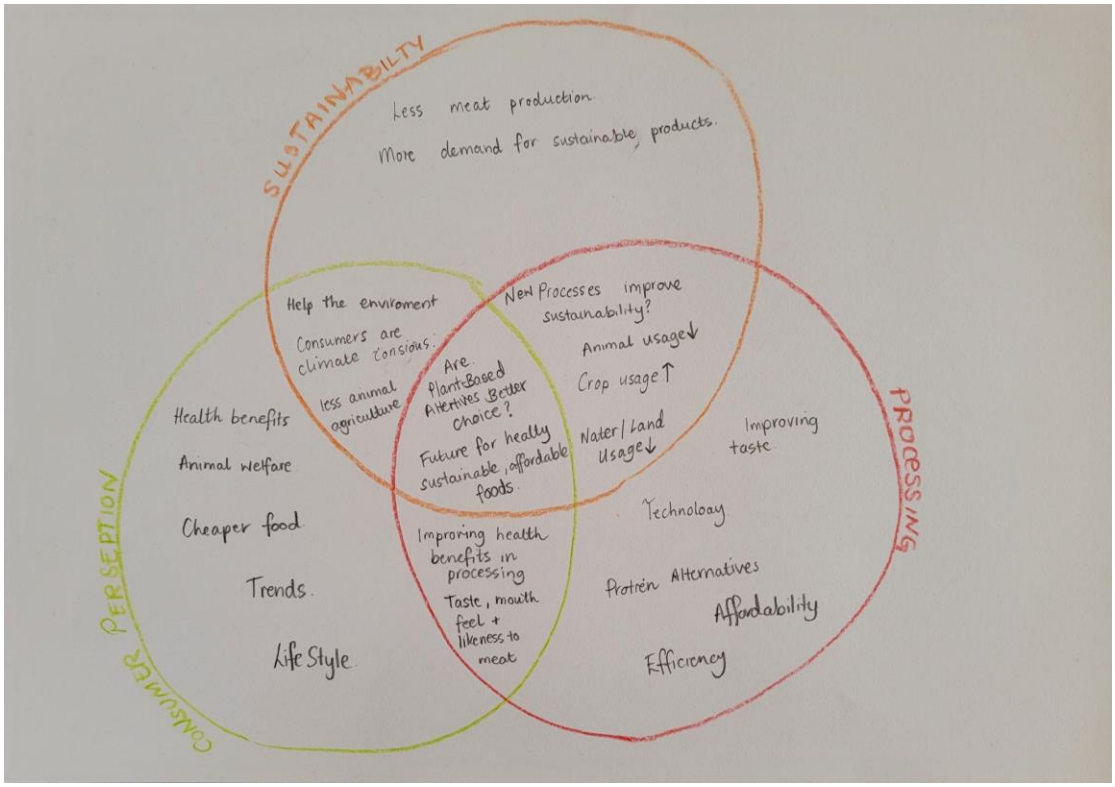
This study has the potential to give fresh insights into national market trends and may aid in understanding the demands of consumers, such as whether or not people are interested in replacing meat with plant-based alternatives to meat. If so, how often and for what reasons is this the case?

The following are some questions that can be helpful in finishing the research:

- Are there any advantages to choosing plant-based alternatives to meat?
- What kind of impression does the Irish consumer get from these products?
- Does sustainability and processing impact on consumption ?

## 1.15 Research Methodologies

To help finding keywords that are relevant to this study the use of a mind map was necessary to help creating question for the survey. A mind map is a kind of diagram that may be used to organise information visually. Creating mind maps is an excellent tool for visualisation, in addition to being useful for brainstorming and planning projects.




### 1.16 Thesis Outline

In order to provide a solution to the research question, Chapter 1 discusses the various PBMAs as well as their definitions. How PBMAs and TMPs are manufactured, as well as the extent to which each product affects the environment.

In Chapter 2, we will discuss the research methods that were used in order to answer the current research topic.

While Chapter 3 will give the results and findings, on how data was carried on tasting panel and online survey

Chapter 4 will critically discuss the findings, drawing verified expectations on the validity of the research question addressed in this study.

In the last chapter will draw some conclusions from the research as well as discuss its limits.

Finally an appendix with extra material used in this study.

# Chapter 2

## Methods and Materials

## 2.1 Methods Study Design

This section provides an overview of the methodologies that were used to highlight the differences in how consumers perceive traditional meat products (TMPs) versus plant-based meat alternatives (PBMAs) . This research relied heavily on primary data. To gather this data, an online 28 question survey was conducted (N = 136 ), as well as a tasting panel that analysed the organoleptic qualities of six products (3 PBMAs and 3 TMPs) with trained participants (N = 16).

In the course of the primary study, both qualitative and quantitative data were gathered. To acquire this main data a Survey and a Tasting Panel were elaborated to conduct this research.

The online cross-sectional survey was administered to co-workers and acquaintances via word-of-mouth//link sharing over the months of June and July 2022. The tasting session was also conducted during this time period. In order for this study to go forward, the Ethical Review Committee at the Technological University of Dublin (TU Dublin) gave its approval.

After reading the condensed information, participants gave their tacit consent to take part in the Survey as well as the Sensory Panel, all of which were anonymous and optional.

## 2.2 Thesis Research Philosophy

While getting a better understanding of the scientific literature, I developed a conceptual framework in order to assist my research focus into what factors should be taken into consideration while carrying out this study.

The below schematic represents the topics of most interest and their relations.

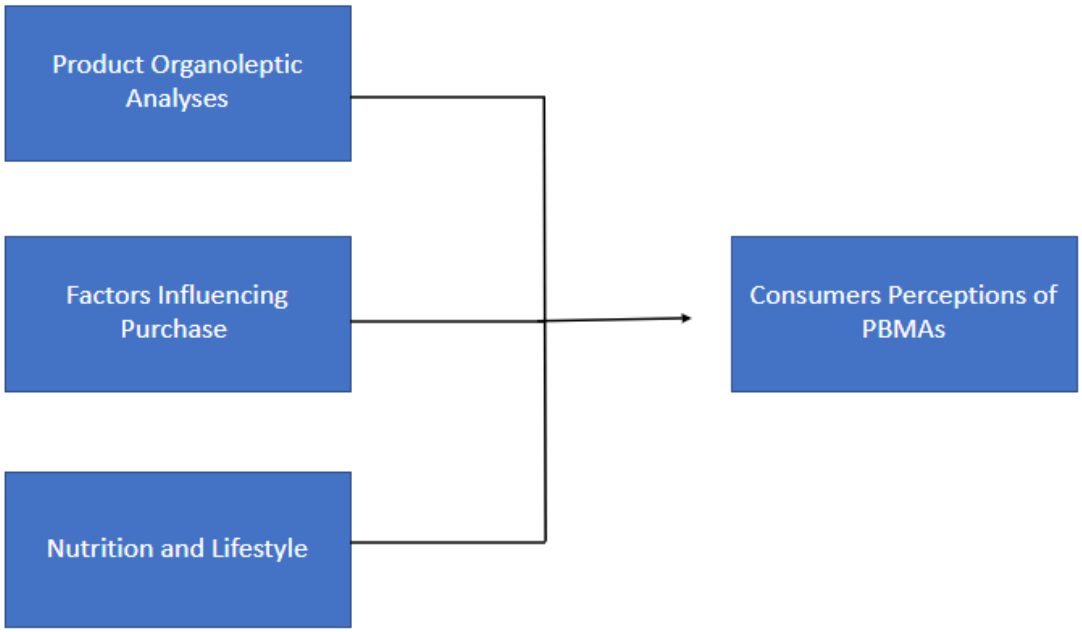



**Figure 2.1 -** Conceptual Frame Work

The ability to examine and investigate about the interrelationships between various aspects of the world is facilitated by the use of a conceptual framework.
Before designing the diagram a few steps were followed;

- Topic choice
- Research question
- Carry out a review of the existing research:
- Variables
- Relationship between variables

### 2.2.1 Topic choice

The title of the thesis summarises the general topic "Are Plant-based Meat Alternatives a Better Choice? Comparing the Consumer Perceptions, Among Other Factors of Plant-based Meat Alternatives Against Animal Origin Products." where a broad overview at the introduction chapter explained many areas of PBMAs and TMPs.

### 2.2.2 Research question

On the other hand, the research question has to have a specific and narrow focus. It is essential that each and every detail be stated in a way that is both crystal clear and succinct. To put it another way, here is where your mental model comes into play as an important factor. The question "Do consumers believe PBMAs are a better alternative than TMPs?" is the one that will be used to restrict the findings of this study.

### 2.2.3 Carry out a review of the existing research

This helped limit down the scope of the items that needed to be emphasised in the conceptual framework. This was covered in great detail in the first chapter.

### 2.2.4 Variables

After reading many scientific articles and papers on PBMAs and TMPs selected content was chosen as variables for this research. These are Product Organoleptic Analyses, Factors Influencing Purchase and, Nutrition and Lifestyle.

Product Organoleptic Analyses; is the process of collecting, defining, and evaluating data with regards to a product in order to reach more informed decisions. This information was collected via Tasting Session. Panellists were provided with a rating sheet and asked to evaluate products based on their overall preference, taste, texture, and aftertaste. This is investigated further by the open-ended questions included in the survey, such as "Does the appearance of these products influence you to buy such?”

Factors Influencing Purchase; There are a variety of elements that might play a role in determining whether or not a customer will make a purchase, including economic, functional, marketing, personal, social, and cultural considerations. The online survey investigated each of these aspects in further detail.

Nutrition and Lifestyle; these includes personal diet, environmental agenda, and nutritional content of products also explored in the online survey.

### 2.2.5 Relationship between variables

Show how these variables are related to each other. In this case the three variables are all interlinked and are determining Consumers Perceptions of PBMAs vs TMPs.
After determining values for all of these elements, a constructed conceptual framework was created and represented in Figure 2.1.

## 2.3 The Survey

An online survey was sent to (i) co-workers who also participated in the tasting session on their own free will and to (ii) a bigger group of consumers who are not affiliated with the organisation. I will advertise the survey through my professional network (including LinkedIn, etc.) as well as other social media platforms (including Instagram and Facebook). This was accomplished through the use of "Microsoft Forms" as a platform, which allowed for the data to be easily analysed and recorded in my TU Dublin email.

The questionnaire addressed consumers' perspectives on PBMAs and TMPs with regard to issues of sustainability, processing, dietary habits, and lifestyle. The objectives of the research project were detailed in an electronic leaflet that was sent to the emails of my employees. In the leaflet, I introduced myself and stated the goals of the study. Anyone who indicated interest in taking part in the survey was given a link to it using Microsoft Forms, which was utilised to distribute the link. It was established, based on a test run of the survey, that the amount of time necessary to finish it would range anywhere from 15 to 20 minutes, depending on the length of the replies. It is important to note that the completion time for the open-ended questions was anticipated to be one minute, but the completion time for the Likert-style questions and the ranking questions was predicted to be substantially shorter.

People interested in participating received this link to the survey https://forms.office.com/pages/designpagev2.aspx?lang=en-IE&origin=OfficeDotCom&route=Start&subpage=design&id=yxdjdkjpX06M7Nq8ji_V2hDfDKnDqiFJqBjWorlrWwtURTg2RU5MQkQ2UFlENFpLNTZEQTlLUFZOM

S4u using Microsoft Forms, and a consent question was stated in the first page of the survey. All information was kept on TU Dublin student email and then analysed.

The survey was titled "Consumer Perception on Plant-Based Meat Alternatives vs Animal Based Products".

Followed by an introduction informing the reader *"This online survey is being distributed in support of a research project being conducted by Joseph Perez as partial fulfilment of the Master's Degree in Food Business Management and Technology at TU Dublin 2022. You can contact Joseph Perez at this email address with any queries regarding this research at: X00181152@myTUDublin.ie . The survey should take approximately 15 to 20 minutes for you to complete. This Survey will explore Irish consumers' perceptions and attitudes toward Plant-Based Meat Alternatives (PBMAs) looking at key areas of interest in decision-making when choosing foods i.e. Meats vs PBMAs Title of Research Project: Are plant-based meat alternatives a better choice? Comparing the sustainability, processing, consumer view, and health factors of plant-based meat alternatives against animal origin products"*.

Questions were structured as follows in table 1.1. can be found in the appendix session.

### 2.3.1 Sample size determination

A sample size of 135 participants was to be used in the survey. This number was calculated using the Zoho stats calculator. This website offers a mathematical technique that is tailored for use in surveys. It describes how the three S's system (size, selection, and sides) should be the first thing to think about while conducting a survey .(Zoho, 2022)

The word "size" refers to the needed minimum number of participants. It should not be too small, nor should it be too large, since large sizes would either be impossible or too expensive, and little samples would simply be unreliable. The survey's primary focus will be on the group known as Selection. Last but not least, a representative cross-section of the population need to be included in the size of the sample.
Using the model of the "three S's," which is the basis for my research:

- The size should be proportional to the Irish consumer population
- Selection should exclude people with allergies; and also exclude age groups outside the 18-65 years old bracket
- Sides is covered due to the amount of the Irish consumer population

It is necessary to have the size of the population, the confidence level, and a margin of error in order to successfully determine the appropriate sample size for this survey and fulfil the statistical limitations that have been set. According to Statista, there are around 3.1 million persons in the Irish consumer population between the ages of 18 and 65. The population size for this research represents that demographic (Statista, 2021).In addition, participants who have severe allergies could not take part in the survey. The FSAI estimates that there are around 100,000 persons in Ireland who suffer from severe allergies (FSAI,2011). Taking into account both of these characteristics, the figure corresponds to a desired population of around three million people.

According to Zoho, the confidence level is inside a certain confidence interval. A confidence interval is a measure of certainty that indicates how well a sample matches the population that is the focus of an investigation. The three degrees of certainty that are most often used are called 90%, 95%, and 99%, and each has its own z-score(Zoho, 2022).For the sake of this research, we shall be using 95%.

The degree of uncertainty that may be associated with the findings of a survey is referred to as the margin of error. This percentage reflects how closely the opinions of the general population should follow the findings of your study. The closer you get to knowing the correct response, the less the margin of error will become. The range of

inaccuracy that may be considered acceptable is often between 4% and 8% points. As a result of the time constraints placed on the data collection process and the purpose of this research, the margin of error was set at 8% (Zoho, 2022).The calculations and of sample size population are discussed in the results chapter.

The purpose of the study was to investigate the ways in which consumers see PBMAs in comparison to goods derived from animals in terms of topics such as processing, health, and personal preferences. In order to collect both qualitative and quantitative information, there will be a combination of open-ended and closed-ended questions in the survey. The response rate as well as the total number of people who filled out the survey were recorded on the Microsoft forms before the data was analysed.

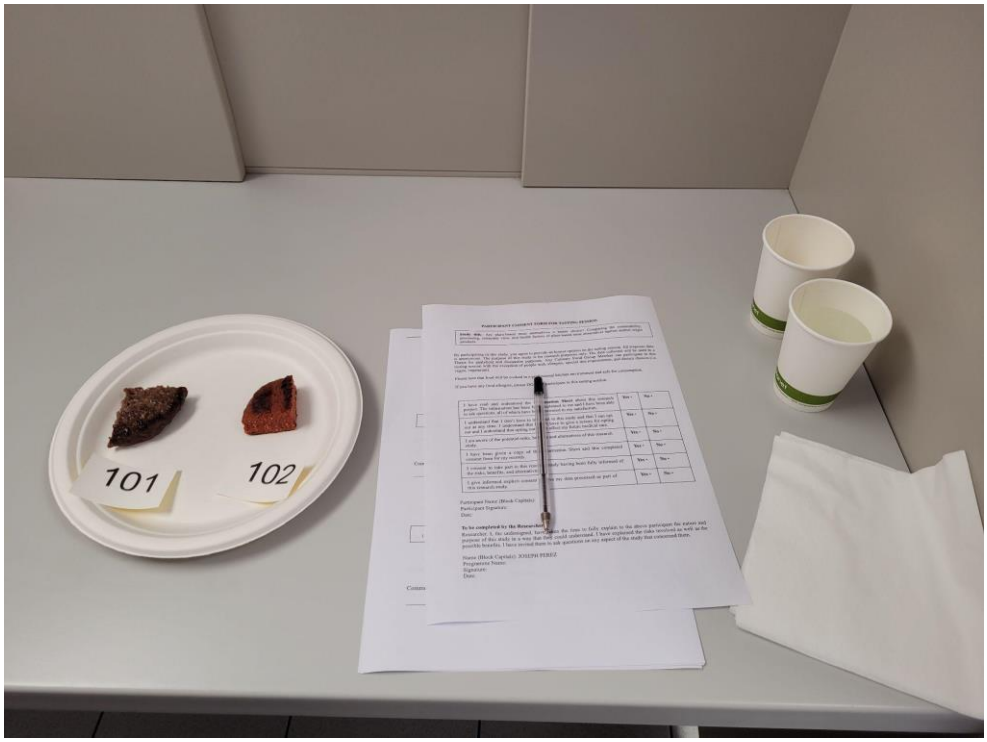
### 2.4 Tasting session

According to the Society of Sensory Science, a food company or a researcher may conduct a sensory evaluations by asking a group of individuals (either assessors or customers) to give either subjective or objective opinions (Society of Sensory Science, 2016).

The tasting was hosted by a food company known as The Culinary Food Group (TCFG), which has its headquarters in Naas, which is located in County Kildare, Ireland. TCFG is a food producer that focuses on producing natural stocks, sauces, pasta, and prepared ingredients for the culinary industry. The firm does not make any of the goods that are being utilised in this research so that the results will not be skewed.

Since of the availability of its facilities, the TCFG was selected as the location for the tasting sessions because it includes a sensory laboratory where these sessions are carried out on a regular basis. In addition, the firm has panellists who have received training and are qualified to participate in organoleptic tasting sessions. These were appropriate conditions for carrying out a research that has the potential to provide qualitative data analysis.

Within the grounds of TCFG is a sensory room that has separate tasting cabinets (see figure 1) where no one else may affect the panellists' responses while they are participating in the session. Food was pushed through a cabinet along with a tasting sheet, pen, and lastly, water will be given for the purpose of washing the palate in between tasting sessions.




**Picture 2.1:** Tasting cabinet at TCFG

In order to be able to get people together for the tasting session, a meeting was arranged with the product development manager. During this meeting, the aims and procedures of the study were addressed, and the firm gave its unanimous approval to both of these aspects of the research.

Colleagues at the workplace were given an electronic booklet in the form of an email that explained the goals of the research and invited them to participate in the tasting session. The following was said in the electronic leaflet:

"*Email to: CIS TCFG Team*
*Subject: Survey and tasting session on consumer perception of plant-based meat alternatives against animal products*

*Hello all,*

*For those who haven't met me, my name is Joseph Perez. I am the new product development chef. I joined the TCFG team in March 2022.*

*I am writing to you to request your participation in a brief survey and a food tasting session. I am currently doing a Master's in food business management at TU Dublin. My thesis is titled "Are plant-based meat alternatives a better choice? Comparing the sustainability, processing, consumer view, and health factors of meat analogues against animal origin products".*

*The focus will be on plant-based meat alternatives vs animal products, focusing on sustainability, processing, and consumer perceptions of such products. I am looking for anyone interested in participating in a tasting session and answering a brief survey. I have full support from TU Dublin and Dr Aine Behan, my thesis supervisor. The Culinary Food Group also offered help by consenting to use the sensory room for my tasting session.*

*There will be two types of research, a food tasting session that will be conducted over in the sensory room and will take no more than 60 minutes of your time. If you would like to join in, please reply to this email, and I'll send you a consent form. If agreed, I will set up a date and time for the tasting session. There will be three meat products and three plant-based meat alternatives to taste, compare and discuss. Please do not volunteer for the tasting session if you have any food allergy conditions.*

*There is also an online survey that can be completed at any time. This survey will take between 15 to 20 min to complete depending on response length". Please note that the open-ended questions are expected to take one minute to complete but the other Likert style and ranked questions take much less to complete.*

*Your Participation in the survey and tasting session is completely voluntary and all your responses will be kept confidential. No personally identifiable information will be associated with your answers to any reports of these data.*

*If interested please contact me at X00181152@myTUDublin.ie*

*Thank you very much for your time and cooperation.*

*Sincerely,*
*Joseph Perez*”

Before taking part in the session, the individuals who were going to partake in the tasting were had to complete a Consent Form. After signing the agreement, the participant was officially invited by email, which included information on the session's date and time.

Employees of TCFG were the only persons who were permitted to take part in the event, which brought together members of a variety of departments, including marketing, sales, technical, development, manufactory, environmental, and quality teams. Each member of the staff has already taken part in tasting sessions, and the organisation provides them with training on the job. There was no attempt made to obtain age, gender, or any other personal information. People who have food allergies, dietary restrictions, or dietary preferences (such as vegans or vegetarians) were not allowed to participate.

Only eight to twelve trained tasters are required for a tasting, as stated by the Institute of Food Science and Technology. (IFST, 2022).

In order to avoid any impression of bias, it is important to point out that none of the products or ingredients used during the tasting session are sold or produced by TCFG. Because of this, the research was translated nationally to reflect Irish consumer attitudes to generally available PBMAs and TMPs.

A local supermarket was visited in order to get food products. There were a total of six different items that were prepared in the research and development kitchen of The Culinary Food Group by myself (the Development Chef) utilising the regular procedures for safety and cleanliness. During the cooking process, we used a calibrated probe to confirm that the temperature of each product had reached at least 72 degrees Celsius. It is crucial to emphasise that all of the items were cooked properly in accordance with the instructions found on the back of the packaging.

Checking the product's temperature is a standard procedure carried out within the food business to ensure that the end product is fit for human consumption. The products that were utilised for the tasting session included burgers, sausages, chicken tenders, and the plant-based equivalents of these items.

The following are the instructions that were given to the panellists about how to conduct a tasting session:

- Consent sign - Panellists were asked to sign a consent form. The aims of the tasting session were outlined in the consent form, and it was made clear that participants might withdraw their participation at any moment.

- Introduction – welcome participants, go through the ground rules for the activity, and discuss some terminology. (i.e. an explanation of what the organoleptic profile of a meal is)

- Objectives - The purpose of the session is to brief participants on the objectives of the session, which is the aim of the session.

- Project Background – Share background information

- Taste the products – Silent evaluation on appearance, colour, odour, taste, and texture. The panellists were provided with a hedonic score sheet and directed to rate the goods in accordance with their own personal preferences.

### 2.4.2 The Tasting Session

During the tasting sessions, water was offered; this allowed for the palate to be neutralised, which resulted in clearer findings when tasting samples. During the course of the session, you were not permitted to consume any additional beverages. Before beginning the tasting session, participants were given strict instructions to abstain from smoking and coffee consumption for at least a half an hour.

The participants in this session were given the task of sampling three TMPs and three PBMAs of relevance. In order to avoid any indication of bias, the brand names were concealed throughout the tasting session, and the products were instead labelled with numbers (101, 102, 201,202,301, and 302).

**Tasting 1 -** Retailer Beef Burger labelled as 101 (see picture 2) vs Sons of Butcher Plant-based Burger labelled as 102 (see picture 3).

- Part 1: Product 101 tasting and organoleptic acceptance score sheet 101
- Part 2: Product 102 tasting and organoleptic acceptance score sheet 102
- Part 3: Sheet comparison of products 101 vs. 102


**Picture 2.2:** Retailer beef burger


**Picture 2.3:** Plant-based burger


**Picture 2.4:** Products 101& 102 Cooked

**Tasting 2 -** Moypark Chicken Goujons labelled as 201 (see picture 4) vs. Retailer Plant-based Goujons labelled as 202 (see picture 5).

- Part 1: Product 201 tasting and organoleptic acceptance sheet 201
- Part 2: Product 202 tasting and organoleptic acceptance sheet 202
- Part 3: Sheet comparison of products 201 vs 202


**Picture 2.5:** Moypark chicken Goujons


**Picture 2.6:** Retailer Plant-based Goujons

**Picture 2.7:** Products 201& 202 cooked

**Tasting 3** - Retailer Pork Sausages labelled as 301 (see picture 6) vs Sons of Butcher Plant-based Sausages labelled as 302 (see picture 7).

- Part 1: Product 301 tasting and organoleptic acceptance sheet 301
- Part 2: Product 302 tasting and organoleptic acceptance sheet 302
- Part 3: Sheet comparison of products 301 vs 302



**Picture 2.8:** Retailer Pork Sausages **Picture 2.9:** Sons of Butcher Plant-based Sausages


**Picture 2.10:** Products 301& 302 Cooked

In all, there were three different question sheets, one for each distinct category of product. This acceptance sheet has an organoleptic rating table based on a nine-point hedonic scale, as well as relevant open questions at the very end. A T-test will be used to establish whether or not there is a significant difference in results between the variables. In tasting panels, it is usual practise to conduct this kind of analysis. Paper versions of the question papers were used in order to fit the various settings of the tasting. Acceptance sheets can be found in the appendix session.

### 2.4.3 The 9-point Hedonic Category Scale:

The 9-point Hedonic Category Scale is the most common scale used to measure consumer preferences. This category functions as a point system with a range that extends from 1-9, or from like something strongly on one end to disliking something strongly on the other (shown in picture 2.9). The gap between each point on the scale symbolises an equal span of psychological development. In order to better understand a customer's desire for a particular product, the food business makes extensive use of this approach.


**Picture 2.11:** 9-Point Hedonic Scale Example

### 2.4.4 Participant Selection

For the purpose of the survey, a participant who is interested in taking part in the study has to be between the ages of 18 and 65 to be considered for inclusion in the research.

Only TCFG employees who had received internal training, were knowledgeable of how to appropriately participate in tasting sessions in accordance with internal training and protocols, and did not have any food allergies, special dietary requirements, or dietary preferences (such as being vegan, vegetarian, or unable to eat meat) were allowed to be a part of the study. This was necessary for the tasting session. Participants who had any of the aforementioned dietary problems or who did not fit within the age range of 18 to 65 were not allowed to participate in the research.

Work colleagues received an email including an electronic leaflet containing all of the information that is relevant to the survey. For individuals that are not affiliated with the company, the survey was promoted via my professional network (LinkedIn) and other social media platforms (including Instagram and Facebook). No personally identifiable information, such as names, ages, or statuses, will be gathered for the purpose of this research.

### 2.4.5 Participant Consent

While the project is fully supported by the company, it is not a company-run study and the company has no input or say over who participates in the tasting session/survey and will not be privy to any of the data collected for this piece of research. TCFG have kindly given the researcher permission to use premises and this will be the extent of their involvement as it is not a company-led research study.

According to what is said on the e-leaflet and consent forms, every member of the staff is at liberty to accept or decline the opportunity to take part in the survey or tasting session. There is neither a need nor a connection to the firm for participants to act in the capacity of workers in order to encourage their participation as members of TCFG. In order to avoid any confusion over this matter, a new line has been inserted to each of the papers that restates this point. It is vital to note that the online survey

was given to the staff, and that it may be done at any chosen time of the day in the participant's own time. Additionally, there is no pressure or condition in place for the person to fill this out during the tasting session. It has been included to the relevant Ethics materials that the respondents to the survey should use their own personal mobile devices rather than the desktops or laptops provided by their employers in order to respond to the questionnaire.

It is important to keep in mind that TCFG often accepts students from universities for placement and that it has a history of providing premises and resources for studies and academic projects. There is no vested interest from TCFG over who attends or not as it is not a company-led research study.

Prior to the tasting session, those individuals who expressed interest in taking part in the research were given the opportunity to sign a permission form. As a result, only those participants who had previously completed the form and expressed agreement were recruited. On the participant information leaflet as well as in person at the tasting session, participants were briefed about the purpose of the study, the types of products that were being served, and the tasting session itself. Moreover, participants were informed about the types of products that were being served. I want to make it clear that the data that will be gathered will only be used for the objectives of the thesis, and that all replies will be kept anonymous. The consent form is attached at the Appendix chapter.

### 2.5 Data Analysis types

The main focus of this research is on primary data analysis. After a particular value has been assigned to a piece of data, that data was then used to describe the entities in question. In order to make this information relevant for analysis, values needed to be arranged before processing and presenting them within a certain context. Both qualitative and quantitative data types were utilised in this study. There are a lot of different procedures included in these; the ones that were used for the purpose of this research are outlined down below.

### 2.5.1 Qualitative data

Using keyword context analysis, participant comments from both the online survey and post-tasting questionnaire were analysed for significant themes. Percentage tables were created using data from the survey.

### 2.5.2 Quantitative data

A Likert scale was utilised as an approach to answer categories in both the survey and the post-tasting questionnaire. This scale reflects the amount to which an individual is satisfied or agrees with a certain statement or question. Organoleptic profile results were analysed using student's T-test.

## 2.6 Data, Anonymity and Confidentiality

On the day of the tasting, only the paper version of the tasting questionnaire was utilised for the tasting panel. The data that was originally stored in hard copy was digitised and entered into an Excel spreadsheet before being analysed and compiled for graphing, interpretation, and debate. The findings of the online survey were subjected to the same analysis and visualisation methods. In the course of this study, no private information will be gathered.

The researcher's laptop is the only device that can access the data stored on the TU Dublin OneDrive account, and it requires a password to do so. All of the research data for this study will be scanned and stored there. No personally identifiable information about the participants will be gathered; in addition, everyone who takes part will maintain their anonymity, and data will be referred to only in aggregate form since individuals will be anonymised (i.e. panellist 1-10).

The survey on consumer perceptions of PBMAs were carried out online with the use of MS forms; the questions asked were only those that are directly relevant to those perceptions. No private or sensitive information will be solicited or gathered under any circumstances.

### 2.7 Data Storage, Retention and Destruction

No personal data was collected for this research, all research data for this study will be scanned and kept on the TU Dublin email and the OneDrive account will be used to store all data collected from the research. TU Dublin OneDrive account is accessible only using the researcher's laptop which is password protected. No personal data on the participants will be collected and all participants will remain anonymous (panellist 1-10).

No data will be disclosed to other parties outside of the remit of this research and thesis publication.

As I do not plan to disseminate this research, all data will be destroyed 2 years after the qualification is received.

# Chapter 3

## Results

### 3.1 Aim of work

The purpose of this study was to identify the perceptions that prevent individuals from eating PBMAs and understand if there is a possibility to increase the likelihood that they would do so in the future. This is because the consumption of these meat-free alternatives that are derived from plants is now at a relatively low level. In order to gather information for this research, a Survey as well as a Tasting Panel were developed. This results session was broken up into two parts: the first portion reported the findings from the survey, and the second half reported the results from the tasting session.

### 3.2 Sample size determination for the online survey

Before designing the questions for the survey, it was necessary to estimate the sample size power required to identify the minimum number of participants needed so that the study would have statistical power.

The information needed to calculate the sample size was the population size (3 million), with a confidence level of 95%, and a margin of error of 8%. This gave a sample size calculation of 135 participants to provide accuracy and power to the data collected. This calculation was performed by using an online calculator and to be certain that the results were accurate, two websites were used, and both gave the same results. The websites used were Zoho and Calculator.net both websites can be found in the reference chapter.

In all, there were 136 people that took part in this research. The equation for the margin of error, based on the data presented above, is shown in Graph 3.1.

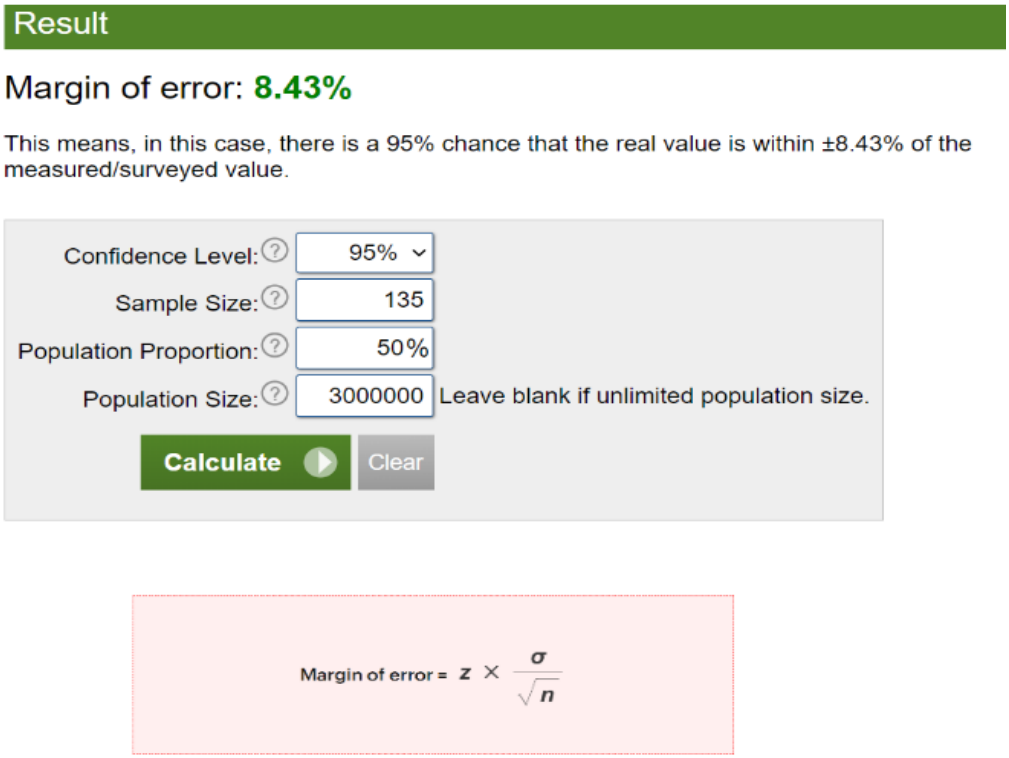



**Figure 3.1** - Margin of error calculation (Taken from calculator.net, 2022.)

### 3.3 Sample size determination for the tasting session

The Culinary Food Group (TCFG), which was pointed out in the methodology chapter, was chosen as the venue for the tasting sessions because it contains a sensory laboratory where similar sessions are carried out on a regular basis and is the place of employment of the researcher and this easily accessible. In addition, the company has panellists that are qualified to engage in organoleptic tasting sessions since they have undergone training and are certified to do so.

There were a total of 15 panellists present for the tasting session, which took place on July 7th, 2012 at twelve o'clock in the afternoon. This is in line with findings from previous studies, which indicated that the majority of sensory tasting sessions in the food industry use between 8 and 12 trained panellists to perform such tests (Djekic, et al.,2021).

### 3.4 Online Survey

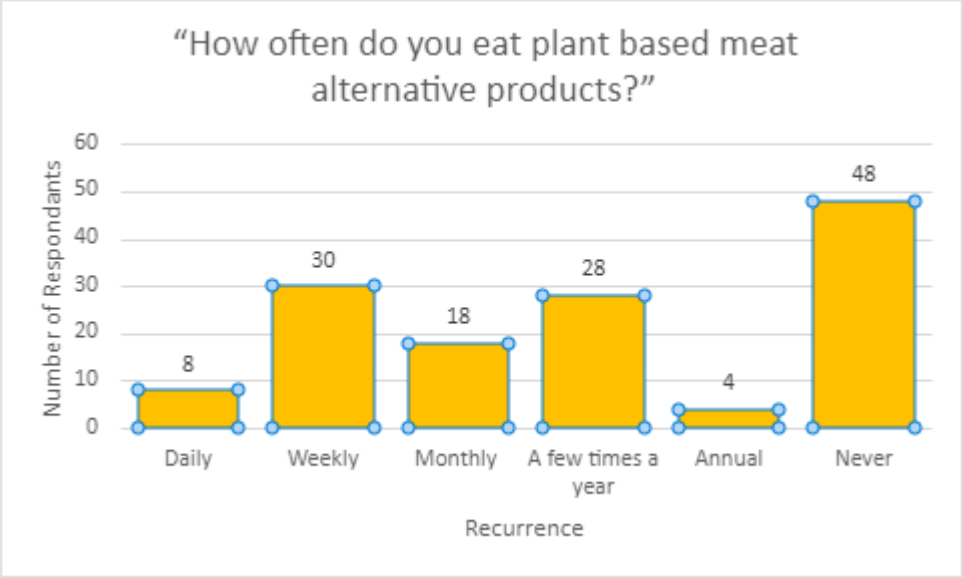
The online survey was sent to employees through email, and it was also shared online via social media to a large number of consumers who are not involved with the organisation. The online survey consisted of 28 questions.

#### 3.4.1 Dietary Options/Questionnaire?

Dietary Options was the main topic of questions two through seven. The results of the second question, which asked "*How would you describe your diet*", are shown in graph 4.3 below, where 51% (N = 70/136) of participants responded "*I consume meat on a daily basis*".


**Graph 3.3:** The responses to the "how would you describe your diet", broken down by the number of people who chose each option.

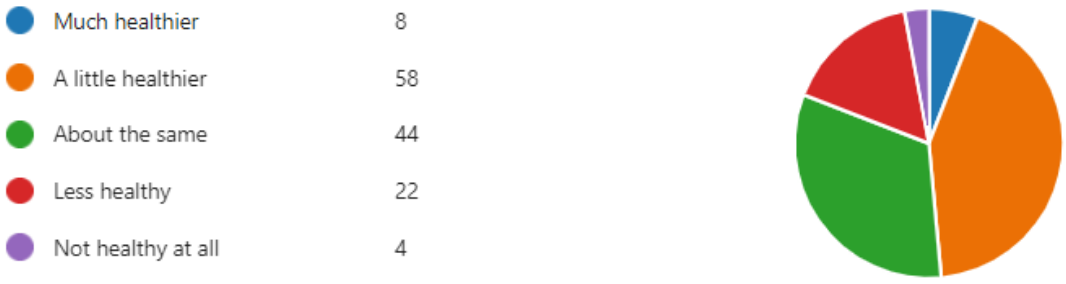
The third question inquired, "How often do you eat plant-based meat alternative products?" 22% of participants (N = 30/136) said that they consume PBMAs on a weekly basis, and inversely 35% of participants (N = 48) indicated that they had never consumed PBMAs (see graph 3.4)




**Graph 3.4:** The responses to "How often do you eat plant-based meat alternative products?", broken down by the number of people who chose each option.

The fourth question queried as to whether or not plant-based meat products are in their perspective healthier than animal products. 41% of respondents (N = 58/136) selected the option "*a little healthier*," while 3% (N = 4/136) selected the option "*not healthy at all* "(see graph 3.5).

Pie Chart: "In your opinion, are plant-based meat products healthier than meat products?"




**Graph 3.5:** The responses to "In your opinion, are plant-based meat products healthier than meat products?", broken down by the number of people who chose each option.

In light of the inquiry that came before it, the fifth question requested that you elaborate on previous answer. It received 122 replies, and a keyword context method

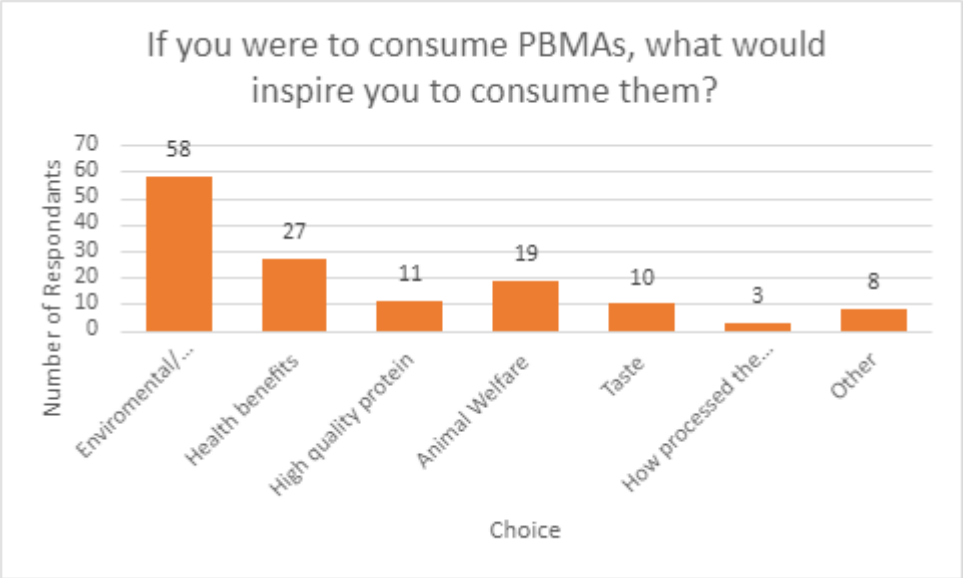
was employed to analyse this open-ended question as a means of data collection (table 3.1)

| Related answers | Common answers |
|---|---|
| *"a little healthier"* | *"Lower in calories and saturated fats"* |
| *"a little healthier"* | *"Typically lower in fat, match meat in terms of protein and higher fibre"* |
| *"a little healthier"* | *"Slightly lower in fat, saturated fat, and cholesterol"* |
| *"a little healthier"* | *"All natural derived from the soil whereas meat products can contain excess fat, salt and sometimes antibiotics etc."* |
| *"a little healthier"* | *"Generally lower in saturated fat, however some products are still processed and can be high in salt and fat"* |
| *"about the same"* | *"I believe both products are processed"* |
| *"about the same"* | *"Proceed food is Proceed food"* |
| *"about the same"* | *"They still very processed"* |
| *"about the same"* | *"They are very processed as well as burgers and sausages"* |
| *"about the same"* | *"They are as processed as the meat options"* |
| *"Less healthy"* | *"Sodium, preservatives and other unhealthy ingredients"* |
| *"Less healthy"* | *"Too much preservatives"* |
| *"Less healthy"* | *"Preservatives"* |
| *"Less healthy"* | *"The amount of ingredients that go into plant-based products is substantial. If you look at the ingredients a lot of these ingredients aren't that healthy. My philosophy on eating food is generally if it has a lot of ingredients in it it isn't likely to be that healthy. Coupled with the fact that humans have evolved to consume meat. Just to clarify I eat organic (when I can) steak, chicken, fish. I rarely consume burgers,* |

| | |
|---|---|
| | *sausages, processed etc."* |
| *"Less healthy"* | *"Prepared industrially, processed, often high in salt, mimicking meat so extra seasoning added for correct flavour and right texture etc."* |

**Table 3.1:** Key words highlights

The sixth question posed the following scenario: "If you were to consume PBMAs, what would inspire you to consume them?" 42% of respondents (N = 58/136) stated that it would be for the environmental or sustainability impact, 20% (N = 27/136) due to health benefits, 14% (N = 19/136) animal welfare and 8% (N = 11/136) due to High-quality protein, and 5.8% (N = 8/136) due to other reasons not stated (see graph 3.6)




**Graph 3.6:** The responses to "If you were to consume PBMAs, what would inspire you to consume them?", broken down by the number of people who chose each option.

If you answered "other" to the preceding question, the seventh question prompted you to explain and expand on why you made that selection. Only 15% of participants (N = 20/136) responded to this question. Main highlights are sited in the below (see table 3.2)

| **Most common answers** |
|---|

| |
|---|
| *Environment; Animal Awareness. Health benefits... Was a Vegetarian for 12-years. This was motivated for Animal Awareness. Health benefits. No longer a Vegetarian,* |
| *Both Sustainability/environment impact and health reasons.* |
| *All of the above equally* |
| *It would need to incorporate all of the above* |
| *All things being equal, I would choose PBMA. Primary driver would be taste, once taste is equal or better, the other benefits (if any) of PBMA, including animal welfare, make it the obvious choice* |

**Table 3.2:** Key words highlights

### 3.4.2 PBMA product naming preferences

Question eight to twenty eight focused on knowledge and attitudes of consumers towards PBMAs to TMPs.

In the eighth question, it was said that soy is often used as a substitute for meat in PBMAs. If you were to make a decision, which of these names do you think best describes burgers made from soy?

Participants were asked to rate the available options, and the results are shown in table 3.3. The veggie burger emerged as the winner with 29% of responses (N = 39/136).

| **Ranking** | **Percentage** |
|---|---|
| Veggie burger | 29% |
| Plant-based burger | 28% |
| Soy burger | 18% |
| Soy based burger | 10% |
| Meatless burger | 6% |
| No beef burger | 5% |
| None | 4% |

**Table 3.3:** Rankings

If the respondent chose "None" as their first option in question eight, then they were prompted to explain their reasoning and provide an appropriate name for the product in the ninth question. This question received responses from 9.5% of participants (N = 13/136). The most important aspects are shown in the following table 3.4:

| **Most common answers** |
|---|
| *Meat names should not be in front of pack* |
| *No meat names on packaging should be allowed* |
| *It should not have meat names to advertise* |
| *I know that in France all meat names are banned for these products, should be the same in Ireland* |

**Table 3.4:** Key words highlights

In the tenth question, participants were asked to choose a name that they would find more attractive for a plant-based food that is similar to chicken. Participants were given the task of rating the many alternatives presented to them, and the findings can be seen in table 3.5. Plant-based chicken was preferred by 24% of participants (N = 32).

| **Ranking** | **Percentage** |
|---|---|
| Plant-based chicken | 24% |
| Plant-based strips | 22% |
| Vegan chicken | 22% |
| Chickenless | 15% |
| None | 10% |

| | |
|---|---|
| Meatless chicken | 7% |

**Table 3.5:** Rankings

Question eleven asked if you selected "None" as your first choice in question ten, please explain why you did so and provide an alternate option for the name. 14% of participants (19/136) responded to this question. Main highlights are shown in table 3.6 below:

| **Most common answers** |
|---|
| *"Products should be transparent in title. Also, the plant ingredients used should be embraced in title rather than selling product as an alternative to meat"* |
| *"I don't think the comparison is appealing. Give it a name that resembles what's in it"* |
| *"It's not chicken, so don't call it chicken"* |
| *"Do you need to say chicken? Chicken is chicken, plant-based strips is kind of ok"* |
| *"It should not have meat names to advertise"* |
| *"Should be called by the main ingredient. Example soy chicken style product"* |
| *"Names associated with meat should be banned"* |

**Table 3.6:** Key words highlights

Question 12 asked which name would be more appealing for the consumer regarding the plant-based product that resembles meat sausages? Participants were given the task of rating the many alternatives presented to them, and the findings can be seen in table 3.7. Plant-based sausage was preferred by 35% of participants (N = 48).

| **Ranking** | **Percentage** |
|---|---|
| Plant-based sausage | 35% |
| Vegan sausages | 28% |
| Seitan, pea, or soy-based sausages | 18% |
| Porkless sausages | 15% |

| | |
|---|---|
| None | 4% |

**Table 3.7:** Rankings

Question thirteen asked if you selected "None" as your first choice in question twelve, please explain why you did so and provide an alternate option for the name. 8% of participants (N = 12/136) responded to this question. Main highlights are shown in table 3.8 below:

| **Most common answers** |
|---|
| *"It should not have meat names to advertise"* |
| *"Packaging should not mention meat on it"* |
| *"No meat names on packaging should be allowed"* |
| *"Names associated with meat should be banned"* |
| *"Don't pretend there's meat if there isn't any. Instead, call it by the main ingredients."* |

**Table 3.8:** Key words highlights

### 3.4.3 Processing and Visual Appeal

According to question fourteen, PBMAs often have a look that is distinct from that of meat products. Than inquired as to whether or not the visual appeal of such items would impact purchase decisions and why. 88% of participants (N = 120/136) replied this question. 56% (N = 68/120) said yes, 40% (N = 48/120) said no, and 4%(N = 4/120) gave different opinions. The most frequent responses are shown in table 3.9.

| **Most common answers** |
|---|
| *"Yes, generally they look highly processed which is unappealing"* |
| *"Yes, if looks too artificial I wouldn't buy it"* |
| *"Yes, if they look like plastic I won't buy them"* |
| *"Yes, sometimes can look dry and therefore not as appetising"* |

| |
|---|
| *"Yes, they often are very grey and unappealing"* |
| *"Yes as if they are unappealing to look at it would not be favourable to eat despite of its makeup"* |
| *"I care about the taste and nutrition"* |
| *"I don't mind as long as they taste good and are healthy"* |
| *"No not really rather than focusing on the visual look I prefer to focus on the health, taste, and environmental benefits"* |
| *"No, I care about how they taste"* |

**Table 3.9:** Key words highlights

The participant was asked in question fifteen whether they thought meat products such as burgers, nuggets, and sausages were highly processed food products. Only 10% of respondents didn't believe that these items were highly processed whereas 78% believed that they were.(see graph 3.7)

Pie Chart: "I perceive meat products such as burgers, nuggets, and sausages to be highly processed food products"


**Graph 3.7:** The responses to "I perceive meat products such as burgers, nuggets, and sausages to be highly processed food products", broken down by the number of people who chose each option.

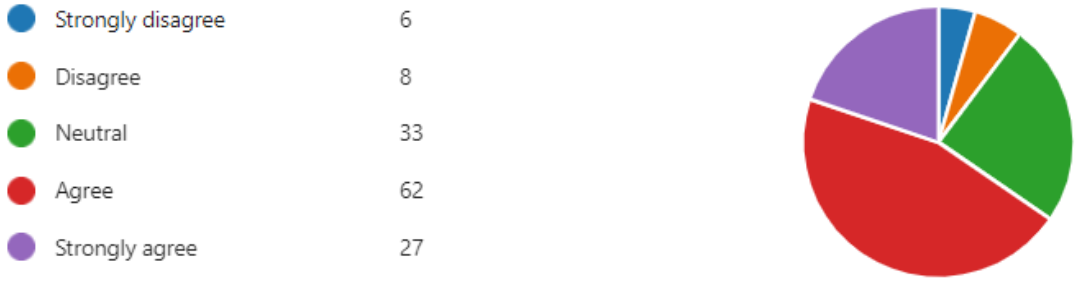
In question sixteen, participants were asked whether they believed that PBMAs were less processed than the meat products that were discussed before. 58% of respondents did not agree with the statement that these goods were processed less than TMPs, whereas 16% believed that they were processed less, and 26% said that the amount of processing was the same. (Graph 3.8).

Pie Chart: “I perceive meat products such as burgers, nuggets, and sausages to be highly processed food products”


**Graph 3.8:** The responses to “I perceive plant-based meat alternatives products to be less processed than the meat products mentioned above”, broken down by the number of people who chose each option.

In question seventeen, we wanted to know whether or not the respondents were concerned about the excessive quantity of added salt in PBMAs. 65% of respondents said that the addition of salt was a cause for worry, whereas 10% disagreed with this assessment. (see graph 3.9).

Pie Chart: “High amounts of added salt in plant-based meat alternatives are of concern to me”



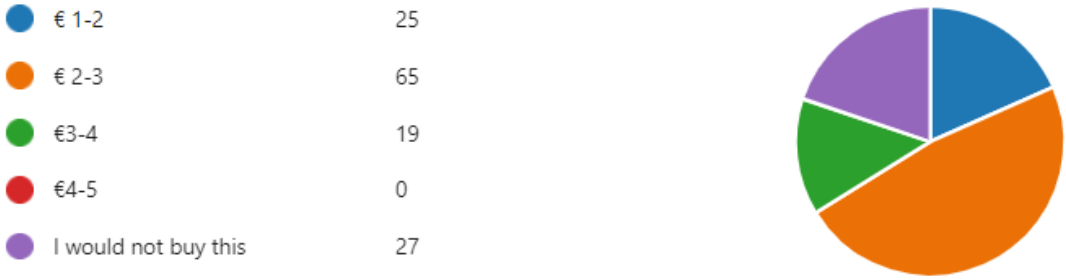

**Graph 3.9:** The responses to “High amounts of added salt in plant-based meat alternatives are of concern to me”, broken down by the number of people who chose each option

### 3.4.4 Cost

The participants were asked in question eighteen how much they were willing to spend for 100g of PBMA burger at a supermarket. 48% of people said that a price

range of €2-3 was appropriate for them. 18% of respondents said that the price range of €1-2 was appropriate, while 20% said they would not purchase PBMAs. (see graph 3.10).

Pie chart: "How much would you be willing to pay for a 100g plant-based meat alternative burger in a supermarket?"




**Graph 3.10:** The responses to" How much would you be willing to pay for a 100g plant-based meat alternative burger in a supermarket?", broken down by the number of people who chose each option

Question nineteen, claimed that PBMAs have been shown to be more sustainable than TMPs. Producing PBMAs requires less land, water, and other resources to complete. On the other hand, the price of these goods is often higher than that of meat goods. The issue that was posed to the participants at that time was whether or not they believed that there would be a difference in pricing that would play a factor in choosing whether or not they would elect to purchase PBMAs. 71% said yes, price impacts purchasing, while 29% said no.

The twentieth question asks for an explanation of the prior question's. 109 people responded table 3.10

| **Most common answers** |
|---|
| *"It shouldn't be more expensive"* |
| *"Plant sources should be cheaper than meat sources"* |
| *"Why is it always more expensive than normal meat? It should be cheaper"* |
| *"Should be cheaper than meat"* |
| *"Plant based should not be more expensive than meat products"* |
| *"Plant should not cost more than meat"* |
| *"Should be cheaper"* |
| *"It should not cost more, but due to low production 8ts generally same price as* |

| |
|---|
| *meat if not more expensive"* |
| *"Plant is generally cheaper than meat, so it should be cheaper"* |

Table 3.10: Key words highlights

In question twenty one, the respondent was asked to choose the kind of food that they were most likely to purchase. 51% of respondents said that they would choose animal products over plant-based alternatives. 28% of respondents claimed that they purchase more flexitarian items, while 16% said that they prefer to purchase PBMAS.

### 3.4.5 Environment and Sustainability

In question twenty two, the customer was asked if they believe PBMAs to be more sustainable than TMPs. There was an affirmative response from 76%. whereas 24% respondents did not agree.

In question twenty three, participants were invited to elaborate on their previous replies. This question was answered by 104 people, and the responses and frequent remarks are shown in table 3.11 below.

| **Most common answers** |
|---|
| *"Yes,less resources required "* |
| *"Yes,takes less recourses to produce "* |
| *"Yes, carbon emissions, plants consume less water and require less land to produce"* |
| *"Yes,less energy required "* |
| *"Yes,less water and land usage "* |
| *"Yes, less land, less water among other resources to produce them"* |
| *"Yes, it has substantially fewer natural resources and is less aggressive to the environment "* |
| *"No, I feel plant based requires highly process ingredients from all over the world to be further processed and then shipped all over the world again once processed* |

| |
|---|
| *for sale on the market. Meat typically is much more locally produced."* |
| *"No, How they are sourced processed and grown has as great an impact as farming"* |
| *"No,Most soya imported to the Irish market , and this is a significant ingredient in plant based alternatives. I would buy local meat before imported meat alternatives."* |
| *"No,The distance that these products travel is long"* |

**Table 3.11:** Key words highlights

In question 24, the respondent was asked whether or not their purchasing choice was influenced by climate change. 65% (N=88/134) of respondents claimed that it did, while 35% (N= 46/134) said that it did not. A total of 134 answered this question.

At question twenty five, participants were asked to expand on what they had said before. Table 3.12 shows the answers and common comments from the 100 people who answered this question.

| **Most common answers** |
|---|
| *"Yes,I buy meats at the local butcher, and veggies at a local market "* |
| *"Yes,I buy the local products from Aldi"* |
| *"Yes,I buy local produce and try to buy as much products produced in Ireland."* |
| *"Yes,I tend to buy local produce "* |
| *"Yes,I tend to buy local "* |
| *"No, enough to be thinking about while shopping and you're trying to choose a healthy alternative than to be also thinking about climate change"* |
| *"No,I don't think about it when I buy something"* |
| *"No,Don't consciously think about it while shopping "* |
| *"No, honestly if I'm in the supermarket doing a shop and I've made a list I don't stop to research the COO of each ingredients - I'm usually in and out. It more impacts my lifestyle choices, recycling, sustainability in clothing and transportation etc,"* |

**Table 3.12:** Key words highlights

The topic of discussion in question twenty six was whether or not consumers were influenced by climate change while purchasing PBMAs rather than TMPs. 134 people answered this question, 60% (N=81/134) of those who took the survey said "yes," while 40% (N=53/134) stated they did not consider it to be relevant.

At question twenty seven, participants were asked to elaborate on what they had previously stated. Table 3.13 displays the responses and common remarks from the 97 participants who responded to this question.

| **Most common answers** |
|---|
| *"Yes,More sustainable "* |
| *"Yes, More sustainable than meat products, produce less emissions"* |
| *"Yes, Animal products may not be sustainable for the longer run and a good choice for the planet due to meat processing requirements, also from a health standpoint, excessive red meat consumption is detrimental to gut health, weight gain etc"* |
| *"Yes, Plant based generally considered greener and a lower contributor of GHGs, a well pushed fact to the general public."* |
| *"Yes, Less land, less water among other resources to produce them"* |
| *"Yes, I expect it to be more sustainable"* |
| *"No, I eat what I like to eat"* |
| *"No, I like the taste of meat"* |
| *"No,I like to eat meat"* |
| *"No, I still like meat"* |

**Table 3.13:** Key words highlights

In question twenty eight, the responder was asked whether they would be willing to consume more PBMAs and if so, why. The results of the 123 respondents are summarised in Table 3.14, which lists the most frequent responses. 60% (N = 74/123) people said yes,35% (N= 43/123) said no, and 5% (N= 6/123) said maybe depending.

| **Most common answers** |
|---|
| *“Yes, I would eat more if there was healthier and tastier options ”* |
| *“Yes, I would probably eat more if they were cheaper and tasted good ”* |
| *“Yes, I would want to only if they are healthier and taste good”* |
| *“Yes, if products can offer healthy factors as well as taste ”* |
| *“Yes, I would if they tasted good.”* |
| *“Yes, if products can offer healthy factors as well as taste ”* |
| *“No, I am not a fan of it. I have seen it in restaurants as "plant based chicken" and this turns me off as it implies something as fake. ”* |
| *“No, I don't like them”* |
| *“No, they look gross”* |
| *“No, they taste awful ”* |

**Table 3.14:** Key words highlights

### 3.5 Tasting Session

The tasting session was carried out in a sensory lab at TCFG, and a total of 15 individuals took part in the research project. As was noted before, each participant was given a score sheet according to the product category (represented in table 3.1). It is essential to emphasise that the participants lacked any knowledge on the product and were unaware of whether the product was derived from plants or animals. In order to eliminate any potential for bias, the items were labelled as described in chapter 2.

| Product category | TMPs | PBMAs |
|---|---|---|

| | | |
|---|---|---|
| Burgers | 101 | 102 |
| Tenders | 201 | 202 |
| Sausages | 301 | 302 |

**Table 3.** Products that were sampled and evaluated during the tasting session

Following the tasting session, the data were scanned using an application for mobile phones called "Simple Scanner," which has the capability of converting photographs into a pdf file. After the conversion, all of the data were computed using an excel file, and a tab was created for each product category with the corresponding organoleptic characteristics and questions. These characteristics and questions are as follows: overall liking, appearance, aroma, taste, texture, after taste, comparison sheet question 1, comparison sheet question 2, and comparison sheet question 3. (expressed in table 3.2).

| | A | B | C | D |
|---|---|---|---|---|
| | Panelists | Sample 101 | Sample 102 | Comments |
| | 1 | 8 | 3 | 101 Tasted natural, good meaty texture but was quit grey.102 look good bright and appealing but taste was quite artificial and texture soft. |
| | 2 | 7 | 7 | |
| | 3 | 7 | 3 | |
| | 4 | 7 | 8 | I though the 102 sample had more flavour, the char makes added to my enjoyment of this sample |
| | 5 | 8 | 8 | |
| | 6 | 8 | 7 | Both very pleasant to eat. I enjoyed both samples equaly |
| | 7 | 7 | 5 | sample 102 very sweet, off putting colour strange texture |
| | 8 | 8 | 3 | 102 slight artificial aftertaste |
| | 9 | 7 | 4 | |
| | 10 | 9 | 3 | 101 Taste really good, 102 not to my liking |
| | 11 | 5 | 7 | 201 colour a little unnatural looking but pleasant overall, 101 is a standard beef burger overall ok |
| | 12 | 6 | 4 | 101 had a better texture and flavour |
| | 13 | 9 | 8 | |
| | 14 | 5 | 5 | |
| | 15 | 8 | 3 | |
| | Mean | 7 | 5 | |
| | StDev (S) | 1.222799287 | 2.077085871 | |
| | Variance (s^2) | 1.495238095 | 4.314285714 | |
| | n | 15 | 15 | |
| | df=n1+n1-2 | 28 | 28 | |
| | | | | |
| | T-test (P value) | 0.003134035 | | |

Overall Liking | Apperance | Aroma | Taste | Texture | After Taste | Comparison Sheet Question 1 | Con

**Table 3.2** Table shows raw data recorded of burger products 101 and 102

### 3.5.1 – Organoleptic Profile

The objective of these calculations was to find out if TMPs were statistically more preferable than PBMAs. Across all six parameters (Overall Liking, Appearance, Aroma, Taste, After-taste, Texture) and in all three comparison categories (Burger, Goujon, Sausage) the TMP was preferred significantly more than the PBMA ($P < 0.05$) (see table 3.3).

| Parameters | Overall Liking | Appearance | Aroma | Taste | After Taste | Texture |
|---|---|---|---|---|---|---|
| 101& 102 (P-value < α) | 0.0031 < 0.05 | 0.0061 < 0.05 | 0.0144 < 0.05 | 0.0043 < 0.05 | 0.00005 < 0.05 | 0.0021 < 0.05 |
| | statistically significant | statistically significant | statistically significant | statistically significant | statistically significant | statistically significant |
| 201& 202 (P-value < α) | 0.0011 < 0.05 | 0.0085 < 0.05 | 0.0032 < 0.05 | 0.0009 < 0.05 | 0.0122 < 0.05 | 0.0035 < 0.05 |
| | statistically significant | statistically significant | statistically significant | statistically significant | statistically significant | statistically significant |
| 301& 302 (P-value < α) | 0.0133 < 0.05 | 0.0241 < 0.05 | 0.0078 < 0.05 | 0.0078 < 0.05 | 0.0480 < 0.05 | 0.0109 < 0.05 |
| | statistically significant | statistically significant | statistically significant | statistically significant | statistically significant | statistically significant |

**Table 3.3** The table displays all of the P-values that were acquired for the products that were evaluated during the tasting session.

### 3.5.2 – Post tasting questionnaire (table see 3.4)

At the very conclusion of the tasting session, there were three follow-up questions and the following are the outcomes of those questions:

(i) Which product was your favourite?

| Product | Panellists choice | Most common remarks |
|---|---|---|
| 101 or 102 (Burgers) | 80% of panellist preferred product 101 | "101 had better texture and flavour"<br><br>"102 different flavour and texture" |

| | | |
|---|---|---|
| 201 or 202 (Goujons) | 80% of panellist preferred product 201 | “Nicer texture, flavour, colour odour” |
| 301 or 302 (Sausages) | 73% of panellists preferred product 301 | “301 Overall is tastier and nicer looking product” |

**Table 3.4** The table presents the results of the collecting information.

(iia) How likely are you to buy product 101 over 102?

How likely are you to buy product 101 over product 102? (see table 3.5)

| 9-point hedonic scale | numbers of answers | Percentage |
|---|---|---|
| Extremely Likely | 7 | 46.6% |
| Very Much Likely | 1 | 6.6% |
| Moderately Likely | 2 | 13.3% |
| Slightly Likely | 0 | 0% |
| Neither Likely nor Unlikely | 3 | 20% |
| Slightly Unlikely | 1 | 6.6% |
| Moderately Unlikely | 0 | 0% |
| Very Much Unlikely | 1 | 6.6% |
| Extremely Unlikely | 0 | 0% |

**Table 3.5** The table presents the results of the collecting information for products 101 and 102 (Burgers)

Better visualisation is shown below in the table 3.6, which allows for interpretation of the data shown above.

| How Likely to Buy | Percentage of Panellists |
|---|---|
| Likely | 67% |
| Neither Likely nor Unlikely | 20% |
| Unlikely | 13% |

**Table 3.6** The table presents the results of the collecting information for products 101 and 102 (Burgers).

(iia) How likely are you to buy product 201 over 202?

How likely are you to buy product 201 over product 202? (table 3.7)

| 9-point hedonic scale | numbers of answers | Percentage |
|---|---|---|
| Extremely Likely | 3 | 20% |
| Very Much Likely | 3 | 20% |
| Moderately Likely | 1 | 6.6% |
| Slightly Likely | 6 | 40% |
| Neither Likely nor | 0 | 0% |

| | | |
|---|---|---|
| Unlikely | | |
| Slightly Unlikely | 0 | 0% |
| Moderately Unlikely | 0 | 0% |
| Very Much Unlikely | 1 | 6.6% |
| Extremely Unlikely | 1 | 6.6% |

**Table 3.7** The table presents the results of the collecting information for products 201 and 202 (Goujons).

Better visualisation is shown below in the table 3.8, which allows for interpretation of the data shown above.

| How Likely to Buy | Percentage of Panellists |
|---|---|
| Likely | 87% |
| Neither Likely nor Unlikely | 0% |
| Unlikely | 13% |

**Table 3.8** The table presents the results of the collecting information for products 201 and 202 (Goujons).

(iia) How likely are you to buy product 301 over 02?

How likely are you to buy product 301 over product 302? (table 3.9)

| 9-point hedonic scale | numbers of answers | Percentage |
|---|---|---|
| Extremely Likely | 2 | 13.3% |
| Very Much Likely | 6 | 40% |
| Moderately Likely | 3 | 20% |
| Slightly Likely | 0 | 0% |
| Neither Likely nor Unlikely | 0 | 0% |
| Slightly Unlikely | 2 | 13.3% |
| Moderately Unlikely | 0 | 0% |
| Very Much Unlikely | 1 | 6.6% |
| Extremely Unlikely | 1 | 6.6% |

**Table 3.9** The table presents the results of the collecting information for products 301 and 302 (Sausages).

Better visualisation is shown below in the table 4.10, which allows for interpretation of the data shown above.

| How Likely to Buy | Percentage of Panellists |
|---|---|

| | |
|---|---|
| Likely | 73% |
| Neither Likely nor Unlikely | 0% |
| Unlikely | 27% |

**Table 3.10** The table presents the results of the collecting information for products 301 and 302 (Sausages).

(iii) How likely are you to choose meat free products over animal origin products?

The last question of the tasting session was, "How likely are you to choose meat free products over animal origin products?"(see table 3.11)

| 9-point hedonic scale | numbers of answers | Percentage |
|---|---|---|
| Extremely Likely | 1 | 6.6% |
| Very Much Likely | 1 | 6.6% |
| Moderately Likely | 2 | 13.3% |
| Slightly Likely | 5 | 33.3% |
| Neither Likely nor Unlikely | 2 | 13.3% |
| Slightly Unlikely | 1 | 6.6% |
| Moderately Unlikely | 1 | 6.6% |
| Very Much Unlikely | 0 | 0% |
| Extremely Unlikely | 2 | 13.3% |

**Table 3.11** The table presents the results of the collecting information for all products

Better visualisation is shown below in the table 3.12, which allows for interpretation of the data shown above.

| How Likely to Choose | Percentage of Panellists |
|---|---|
| Likely | 60% |
| Neither Likely nor Unlikely | 13% |
| Unlikely | 27% |

**Table 3.12** The table presents the results of the "How likely are you to choose meat free products over animal origin products?"

# Chapter 4

## Discussion

## 4.1 Discussion

The main aim of the survey and tasting session was to provide insights necessary to answer the research question; Are Plant-Based Meat Alternatives (PBMAs) a better choice? Comparing the sustainability, processing, consumer view, and health factors of PBMAs against animal origin products?

The conceptual frame work discussed in chapter 2 was designed to help interpreting the consumer perceptions of PBMAs

- Factors influencing purchase was acquired from the online survey and comments from the tasting session
- Nutrition and lifestyle was acquired from the online survey
- Product organoleptic analyses was acquired from the tasting session results

The first half of this study surveyed consumer attitudes and beliefs towards PBMAs and TMPs. Predominantly the survey participants (N = 136) were regular meat eaters (76%), with 51% reporting daily meat consumption and 25% reporting sometimes.
In terms of PBMA consumption, a third reported that they never eat PMBAs, while inversely another third reported eating them weekly or monthly (22% and 13% respectively).

When asked to about their perspectives on the healthiness of PBMAs, almost half of respondents (41%) thought PBMAs were “a little healthier” than TMPs. When asked to comment, those responding with “more healthy” commonly mentioned “lower saturated fats and calories”, while those responding with “less healthy” brought up concerns with “preservatives” or “unhealthy ingredients”.

Almost half (42%) stated that they would eat PBMAs for “environmental or sustainability impact”, followed by “health benefits” (20%). 6% of respondents chose the “Other” category, with all expressing comments of “it would need to incorporate all of the above” generally in reference to environment, health benefits, animal welfare and taste.

When asked about preferences in PBMA naming in each category of PBMA (soy plant-based burger, plant-based chicken alternative, and plant-based sausage), the majority of participants preferred names that included the words “plant-based”, “veggie” or “vegan” (e.g. veggie burger/plant-based sausage) over those that referred to the meat (e.g. “meatless burger” / “porkless sausage”). This is reflected in the comments where statements like “meat names should not be in front of pack" or “should be called by the main ingredient” were common.

Just over half (56%) of respondents stated that the visual appeal of PBMAs would impact their decision to purchase, commenting that they look “artificial/like plastic/grey/unappealing” in comparison to TMPs. Similarly, Spendrup et al. (2022) found that generally all food consumption groups expressed differences in “taste, how artificial the product is perceived to be and satiety”, with their “meat only” and “meat and fish only” groups also most likely to hold non-positive attitudes towards PBMAs.

78% believe PBMAs are highly processed, and 58% believe they are more processed than TMPs. 65% worry about excess salt in PBMAs.

Nearly (48%) half are willing to spend €2-3/100g of PMBA, and when described how PBMAs require less resources to produce than TMPs, the majority (71%) stated that pricing would affect their purchasing of PBMAs. Comments like “It shouldn't be more expensive” and “Plant based should not be more expensive than meat products” were most common.

Similar to other studies, three quarters our of participants believe that PBMAs are more sustainable than TMPs (Weinrich, 2019). Significant comments from either response group stated “Yes, carbon emissions, plants consume less water and require less land to produce” and “No, I feel plant based requires highly process ingredients from all over the world to be further processed and then shipped all over the world again once processed for sale on the market. Meat typically is much more locally produced.” Over half (65%) of respondents stated that climate change would influence their purchasing choices, with comments commonly stating “Yes, I tend to buy local produce ” and “No, enough to be thinking about while shopping and you’re trying to choose a healthy alternative  than to be also thinking about climate change”

Over half (60%) stated that climate change would influence them buying PBMAs over TMPs. Comments commonly stated “Yes, Animal products may not be sustainable for the longer run and a good choice for the planet due to meat processing requirements, also from a health standpoint, excessive red meat consumption is detrimental to gut health, weight gain etc” and “No, I eat what I like to eat”.

Sustainability concerns

More than half (60%) would be willing to consume more PBMAs, commenting “Yes, I would probably eat more if they were cheaper and tasted good”

In-line with findings in the literature, our online survey generally found that people were supportive of the environmental sustainability and health benefits PBMAs offer, but many still find the sensory differences yet ungapped (Nezlek & Forestell, 2022).

In the Tasting Session, panellists rated each item's organoleptic attributes on a 9-point hedonic scale. T-test analysis found that participants significantly favoured the traditional meat products on all sense rating categories (Overall Liking, Appearance, Aroma, Taste, After-taste, Texture) to their plant-based counterpart (table 3.3). Sensory preferences for TMPs are still common (Cordelle, et al., 2022; Caputo, et al., 2022)

In response to the question "Which product was your favourite?” the meat-based variants were much preferred by the participants over the PBMA varieties. The majority of responses said that preference for flavour and/or texture was the primary factor in selecting meat products.

The subsequent questions had the same structure: "How likely are you to buy product 101/201/301 over product 102/202/302?”

Burger products (101 and 102) had a preference of 67% on the beef burger (101) primary remarks were “prefer flavour and texture” and “personal taste - prefer 101 did not like 102”

Goujons products (201 and 201) had 87% preference on the chicken goujon (201) highlights were “I prefer product 201” and, “I am more pushed to buy 201 as it offers more protein content and flavour”

Sausages products (301 and 302) had 73% preference on the pork sausage (301) key remarks were “301 i prefer this option -would also decide on how is looked raw” and, “appearance first purchase decision and 301 looks more appealing” once again emphasising the fact that the organoleptics of the plant-based ones did not fulfil consumer expectations.

The last question that was posed to participants during the tasting consisted of “How likely are you to choose meat free products over animal origin products?” In spite of the fact that they prefer animal products in terms of organoleptics, and also answered otherwise in previous questions, 60% of the panellists said that they are inclined to choose the meat-free choice (as shown in table 3.11). This provides evidence that consumers are open to switching their purchase preference, but they are only prepared to do so under certain circumstances. This was a highly prevalent factor, as many of the panellists said that they were likely to purchase the meat-free version. But provide comments such as, “Depends on the product but I would avoid buying meat free more than looking for it” or “I find vegetarian can offer lots of benefits similar to 101. if there is a similar protein content i would chose it.” or “If less calories, healthier option wouldn't buy otherwise” or “like to add meat free to my diet but not likely to replace meat entirely” or “if healthier, fortified or less calories yes”

# Chapter 5

## Conclusion and Future Work

## 5.1 - Conclusion

The survey found that, although the majority of people eat and buy meat on a daily/frequent basis, about half of respondents held various positive views towards PBMAs and were willing to consume more. Conversely, about half of respondents were concerned with taste, visual appeal, texture, price and amount of processing. Climate change and health were the most significant factors in people currently or considering consuming PBMAs. Participants showed a greater preference for PBMA product names which do not reference the meat (e.g. vegan sausages vs. porkless sausages).

In each tasting comparison the TMP (beef burger/chicken/sausages) was preferred over the relevant PBMA. The majority of panellists cited the flavour and/or texture as the primary factors in their selection. Inversely to their ratings, 60% affirmed their likelihood to select meat-free products over animal-origin products.

## 5.2 - Future Work

The survey conducted here was exploratory in nature. Future surveys could focus on how to improve consumer-PBMA accessibility or positive-exposure.

If repeating a tasting panel, a new set of products would be necessary but instead of doing unrelated products such as the ones performed in this work (burgers, sausages, tenders) a more specific analysis could show more differences in people's opinions about PBMAs. For instance offering panellists to score only plant based burgers, a set of five different brands (five plant-based burgers and five beef burgers) might result in different PBMA opinions, maybe a particular brand would reach consumer likings and expectations.

# Chapter 6

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# Appendix

**Table 1.1** Survey Questions

| | |
|---|---|
| Question 1<br>Consent Disclaimer: I understand that the data collected from my participation will be used for purposes of the thesis, and I consent for it to be used in that manner. | Please tick the appropriate choice.<br>( )Yes, I consent to fill out this survey<br>( ) No, I do not consent |
| Question 2:<br>How would you describe your diet? | ( )I eat meat on a daily basis<br>( )Flexitarian (eat meat sometimes)<br>( )Pescatarian |

| | |
|---|---|
| | ( )Vegetarian<br>( )Vegan |
| Question 3:<br>How often do you eat plant-based meat alternative products? | ( )Daily<br>( )Weekly<br>( )Monthly<br>( )A few times a year<br>( )Annually<br>( )Never |
| Question 4:<br>In your opinion, are plant-based meat products healthier than meat products? | ( )Much healthier<br>( )A little healthier<br>( )About the same<br>( )Less healthy<br>( )Not healthy at all |
| Question 5:<br>In relation to the previous question could you please elaborate on why you think this? | |
| Question 6:<br>If you were to eat plant-based meat alternatives, what would motivate you to eat them? | ( )Environmental/sustainability impact<br>( )Health benefits<br>( )High-quality protein<br>( )Animal welfare<br>( )Taste<br>( )How Processed the food is<br>( )Other |
| Question 7:<br>If other - please state the motivation and why. | |
| Question 8:<br>Soy is a commonly used alternative to meat in plant-based meat alternatives. If you had to choose, which name is more appealing regarding soy-based products? Please rank 1 being preferable and 7 least preferable. | ( ) Soy-based burger<br>( ) Soy burger<br>( ) Plant based burger<br>( ) Veggie burger<br>( ) Meatless burger<br>( ) No beef burger<br>( ) None |
| Question 9:<br>If you would rank None as your first option in Q8, please elaborate why or an alternative name choice. | |
| Question 10:<br>Which name would be more appealing to you for a plant-based product that resembles chicken? Please rank 1 being preferable and 6 least preferable | ( ) Chickenless<br>( ) Plant-based chicken<br>( ) Vegan chicken<br>( ) Meatless chicken<br>( ) Plant-based strips |

| | |
|---|---|
| | ( ) None |
| Question 11:<br>If you would rank None as your first option in Q.10, please elaborate why or an alternative name choice | |
| Question 12:<br>Which name is more appealing to you regarding the plant-based product that resembles meat sausages? Please rank 1 being preferable and 5 least preferable. | ( ) Plant-based sausages<br>( ) Seitan, pea, or soy-based sausages<br>( ) Vegan sausages<br>( ) Porkless sausages<br>( ) None |
| Question 13:<br>If you would rank None as your first option in Q.12, please elaborate why or an alternative name choice. | |
| Question 14:<br>Plant-based meat alternatives often look different from meat products. Does the appearance of these products influence you to buy such? Why? | |
| Question 15:<br>I perceive meat products such as burgers, nuggets, and sausages to be highly processed food products. | ( ) Strongly<br>( ) Disagree<br>( ) Disagree<br>( ) Neutral<br>( ) Agree<br>( ) Strongly Agree |
| Question 16:<br>I perceive plant-based meat alternatives products to be less processed than the meat products mentioned above. | ( ) Strongly Disagree<br>( ) Disagree<br>( ) Neutral<br>( ) Agree<br>( ) Strongly Agree |
| Question 17:<br>High amounts of added salt in plant-based meat alternatives are of concern to me. | ( ) Strongly Disagree<br>( ) Disagree<br>( ) Neutral<br>( ) Agree<br>( ) Strongly Agree |
| Question 18:<br>How much would you be willing to pay for a 100g plant-based meat alternative burger in a supermarket? | ( ) € 1-2<br>( ) € 2-3<br>( ) €3-4<br>( ) €4-5<br>( ) I would not buy this |
| Question 19:<br>Plant-based meat alternatives are proven to be more sustainable in comparison to | ( ) Yes |

| | |
|---|---|
| traditional meat products. PBMAs can be produced using less land, water and resources. However, these products can often be more expensive than meat products. Would this cost factor influence your choice to purchase PBMAs? | ( ) No |
| Question 20:<br>Can you elaborate why on your answer choice in Q.19? | |
| Question 21:<br>What type of food product would you be more likely to buy? | ( ) Plant-based meat alternative products<br>( ) Flexitarian products that have fewer animal sources<br>( ) I prefer meat products over plant-based products<br>( ) Other |
| Question 22:<br>Do you currently perceive plant-based meat alternatives to be more sustainable than meat products? | ( ) Yes<br>( ) No |
| Question 23:<br>Can you elaborate why on your answer choice in Q.22? | |
| Question 24:<br>Does climate change impact your decision-making in purchasing? | ( ) Yes<br>( ) No |
| Question 25:<br>Can you elaborate why on your answer choice in Q.24? | |
| Question 26:<br>Do you consider climate change an influencer in buying plant-based alternatives over Meat products? | ( ) Yes<br>( ) No |
| Question 27:<br>Can you elaborate why on your answer choice in Q.26? | |
| Question 28:<br>Would you eat more plant-based meat alternatives and why? | |

## Acceptance Score Sheet:

**How much do you like the …. Of this product**

**(9 - point scale 1 = I dislike very much // 9 = I like very much)**

**Overall Liking**

Dislike Neutral Pleasant

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Sample 101- ( )

Sample 102 - ( )

Comments_____

**Appearance**

Dislike Neutral Pleasant

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Sample 101- ( )

Sample 102 - (  )

Comments_____

**Aroma**

Dislike Neutral Pleasant

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Sample 101- (  )

Sample 102 - (  )

Comments_____

**Taste**

Dislike Neutral Pleasant

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Sample 101- (  )

Sample 102 - (  )

Comments_____

**Texture**

Dislike Neutral Pleasant

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Sample 101- ( )

Sample 102 - ( )

Comments_____

**Aftertaste**

Dislike Neutral Pleasant

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Sample 101- (  )

Sample 102 - (  )

Comments_____

## Comparison Sheet

1- Which product was your favourite?

101 (  )

102 (  )

2- How likely you buy product 101 over product 102 ?

Unlikely

Likely

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Comments_____

3- How likely are you to choose meat-free products over animal origin products?

Unlikely

Likely

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

Comments_____

***"PARTICIPANT CONSENT FORM FOR TASTING SESSION***

| |
|---|
| ***Study title:*** *Are plant-based meat alternatives a better choice? Comparing the sustainability, processing, consumer view, and health factors of plant-based meat alternatives against animal origin products.* |

*By participating in this study, you agree to provide an honest opinion on the tasting session. All response data is anonymous. The purpose of this study is for research purposes only. The data collected will be used in a Thesis for analytical and discussion purposes. Any Culinary Food Group Member can participate in this tasting session with the exception of people with allergies, special diet requirements, and dietary choices (i.e. vegan, vegetarian).*

*Please note that food will be cooked in a professional kitchen environment and safe for consumption.*

*If you have any food allergies, please DO NOT participate in this tasting session.*

| | | |
|---|---|---|
| *I have read and understood the* ***Information Sheet*** *about this research project. The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.* | ***Yes*** • | ***No*** • |

| | | |
|---|---|---|
| *I understand that I don't have to take part in this study and that I can opt out at any time. I understand that I don't have to give a reason for opting out and I understand that opting out won't affect my future medical care.* | ***Yes*** • | ***No*** • |
| *I am aware of the potential risks, benefits and alternatives of this research study.* | ***Yes*** • | ***No*** • |
| *I have been given a copy of the Information Sheet and this completed consent form for my records.* | ***Yes*** • | ***No*** • |
| *I consent to take part in this research study having been fully informed of the risks, benefits, and alternatives.* | ***Yes*** • | ***No*** • |
| *I give informed explicit consent to have my data processed as part of this research study.* | ***Yes*** • | ***No*** • |

*Participant Name (Block Capitals):*
*Participant Signature:*
*Date:*

***To be completed by the Researcher.***
*Researcher. I, the undersigned, have taken the time to fully explain to the above participant the nature and purpose of this study in a way that they could understand. I have explained the risks involved as well as the possible benefits. I have invited them to ask questions on any aspect of the study that concerned them.*

*Name (Block Capitals): JOSEPH PEREZ*
*Programme Name:*
*Signature:*
*Date:"*