Introduction

Imitation meat is a plant-based meat alternative that is increasing in popularity with consumers due to its environmental and health benefits compared to animal meat. Figure 1 shows that numerous companies have started creating plant-based alternatives, catering to different demographic from vegans, vegetarians, and omnivores, using different techniques to try and mimic the flavor, texture, and color of animal meat. This poster analyzes the process of the production of imitation meat, along with looking at the environmental impacts, sensitive units and areas that require future research in order for the implementation of imitation meat to be successful.

Figure 1: Meat Imitation Products from a variety of brands (4)

Process Description

The production process for plant-based meat substitutes begins with the extraction of proteins from raw plant materials, followed by the structuring of those proteins in a process called extrusion or, more rarely, shear cell processes. These procedures use heat and agitation to structure proteins and are critical for the formation of the desired shapes, such as that of a patty. While the general process may seem simple on paper, variables will be used and treated for.(5)

An intake of raw materials is processed in a thermomechanical cooking process. As the screws rotate, the raw proteins are ripped into strands, an unfolded state, and are prepared for die fiberation. During die fiberation, the process proteins then undergo recombinant and bonding reactions to form the finished protein. The general shape of the protein on a molecular level can be observed in Figure 6.

During the die fiberation process, the proteins are formed into a single structure, which can then be altered later into desired shapes, such as that of a patty. While the general process may seem simple on paper, variables present in the system can alter the physical characteristics of the processed proteins, such as the following:

- Temperature: high temperatures are known to disrupt hydrogen bonds and non-polar hydrophobic interactions.
- Moisture: proteins are composed of hydrophilic and hydrophobic interactions, with the amount of moisture affecting the reactions occurring during the process.
- Twin Screw: shape and time in the thermomechanical process can affect the properties of the protein.
- Die: shorter or longer periods can affect the formation of the crosslinked state.

These factors can play a major role in the end product. Texture, for example, can play a determining role in what the product will be used for. A protein sheet classified as rough and short, thick cross section oriented fibers, may be utilized for chicken strips. Meanwhile, a protein sheet classified as smooth and long, with laminar-flow oriented fibers, would be used for a pulled-pork substitute. How a batch of raw material is treated will ultimately determine what the end product will be used and treated for.(5)

Figure 6: Given Protein Structure After Processing Component (5)

Potential Impact Eco. Services

Among those looking for plant-based meats, one of the big reasons is usually to be more environmentally friendly. Some of the impacts people are concerned about are water usage, land usage, greenhouse gas emission, and eutrophication. Figure 3 shows that cattle have the worst effects in energy greenhouse gas emission, eutrophication, and land use, and the second worst effects in energy consumption.(6)

Figure 3: Comparison of the environmental impact of meat and meat analogs (7)

However, the most popular meat across the world is pork at 36% of all consumed meat. According to Impossible Foods (a popular meat alternative brand), the pork substitutes have a much smaller environmental impact.

"Impossible Sausage generates 71% less greenhouse gas and 41% less water footprint, and generates 57% less aquatic eutrophication" (4). Figure 4 shows the difference between Impossible sausages and pork sausages, in both the United States and Asia. Across the board, Impossible Sausage is less impactful on the environment than traditional pork sausages.

Figure 4: Impact of Impossible Sausage vs pork sausage (4)

Giving that beef has some of the worst effects, it is important to consider the Impossible Food version of beef as well, even though it is consumed less frequently than pork. Again, across the board, the Impossible product has a huge reduction in environmental impacts(4).

Table 1: Results for 1kg Impossible Burger vs beef burger (4)

Sensitive Unit

In the process of converting plant-based materials into a meat supplant, the most critical component is that of protein structure. Protein structure uses extrusion technologies to alter the physical properties plant based proteins express. New advancements in the fields are possible due to the twin screw extrusion process. As seen in Figure 5, the process has two main components.

Figure 5: General Model of the Twin Screw Extrusion Process (5)

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Figure 7: Consumer Acceptance based on Structuring Limitations (1)

Research

Imitation meat is currently seen as unnatural. Unfamiliar flavors and textures have caused an issue with consumer acceptance of the products. In order for meat imitation products to be implemented successfully, further research into consumer acceptance is required.

Hypothesis: If imitation meat resembled traditional meat, in both taste and appearance, will consumers be more inclined to switch to imitation meat?

Objectives/Tasks

- Have a focus group of individuals both vegetarian and omnivores, from all sorts of ethnic groups, locations, and socioeconomic backgrounds
- Add multiple focus groups to gather enough data to find similarities
- See what components of imitation meat the individuals in the focus group are most receptive to; rank taste, texture, and color based on importance
- Give focus groups different types of imitation meat and have them record which they liked more and why

Analysis

- Identify patterns between consumer preferences within the focus group to better understand how certain demographics such as patterns within ethnic groups or dietary preferences
- Find which products of imitation meat did the best in each category (texture, taste, and color) and look to replicate each of the processes into one product
- Understand if improvements in these criteria result in acceptance of imitation meat products

Figure 7. Analysis

References