Development of a Flexitarian food product

– The Flexi hot dog

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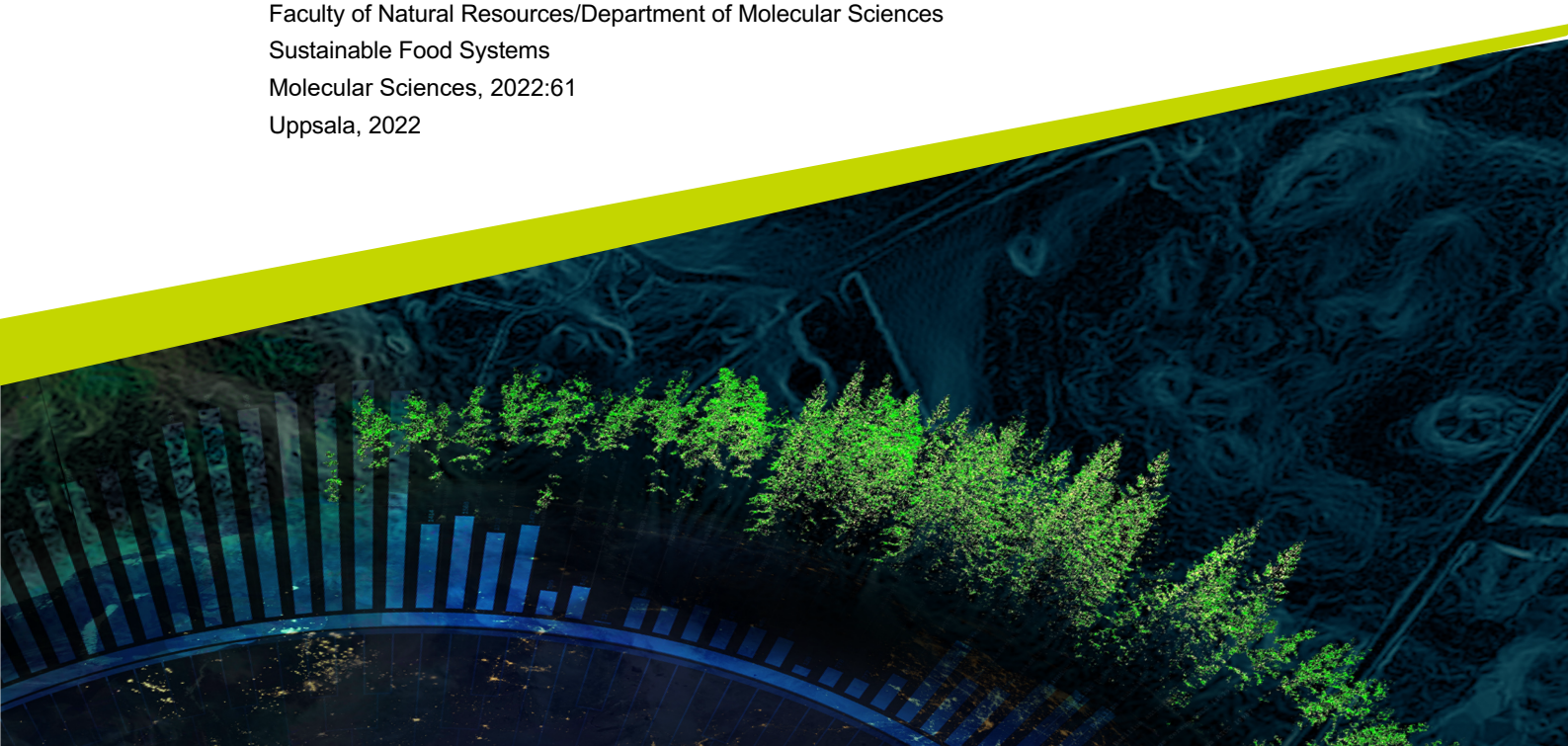

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Summary

Many studies show that plant-based diets are good for both human health and the environment and recommend lowering meat intake considering mounting environmental and animal welfare issues. This facet prompted protein transitions around the world, which in turn aided in the emergence of various diets. Flexitarian is one such diet that encourages people to consume more plant-based meals while also allowing them to eat meat on occasion, unlike other strict vegetarian diets. This project aims to develop a flexitarian food product that will complement flexitarian diet followers as well as consumers looking to minimize their meat intake while offering a tasty flexitarian food product with high nutritional value and minimal environmental impact, by using plant-based ingredients and by-products from the meat industry

Mung beans were used as a plant-based ingredient, whereas cattle blood and pork intestine sausage casing were used as animal-derived components in the Flexi hot dog. Two test products were created, and panel members were invited to taste the sausages and perform sensory evaluations using a 9-point hedonic scale. Recipe 2 containing relatively more blood received a higher rating from panel members and thus became the winning version of the sausage, and however, both sausages overall impression received at the upper half of the scale, thus both products delighted the panel members in terms of sensory elements. In order to validate possible consumer demand, participants were requested to reply to open-ended survey questions to examine the possible target consumers for flexitarian diet and flexi hot dog. Many participants indicated that they would like to follow flexitarian diet and buy flexitarian sausage at least once a month. When examining the nutritional value of the Flexi sausage (based on the Livsmedelsverket food nutritional database for ingredients) compared to vegan sausages, the Flexi hot dog had higher energy, carbohydrate, fibre and iron content, and lower fat content. The Flexi hot dog has a relatively low environmental effect of roughly 1.3 kg CO_2eq/kg, which is similar to vegan sausages, but lower than regular meat sausages.

According to the findings of this study, the flexitarian hot dog pleased consumers' taste palates, while also offering them nutritious flexitarian food with a low environmental impact; moreover, consumers are predicted to purchase this product at least once a month. Future developments of flexitarian food products are recommended to not deviate from the notion of flexitarian and emphasize the use of legumes and animal by-products, for a resource efficient food system.

Keywords: *flexitarian, diets, carbon footprint, sensory evaluation, consumer survey, nutrient assessment.*

Popular-scientific summary

Development of a flexitarian food product – the flexi hot dog

Our planet is currently experiencing temperature increases and climate change. Since the food system has been a substantial contributor to the high CO_2 emissions, and it has been noted that meat production is one of the big contributors. These problems have prompted the need for novel protein shifts that encourage dietary shifts toward plant-based foods. Even though the scientific circles are motivating people to move to a diet rich in plant-based foods, it's hard for the majority to completely avoid meat, as it is a dominant and integral part of most people's lifestyles. Hence it is essential for the diet to be easy to adopt for people who are not completely ready to abstain meat products. A flexitarian diet is a mainly vegetarian diet that allows to eat animal's products on occasion.

This study involves creating a flexitarian product that provide both plant and animal nutrients to encourage and making it convenient for consumers to adopt these eating habits. The developed flexi hot dog product has low environmental impact, does provide good amount of nutrients. The product satisfies consumers taste palettes, and consumers are interested to buy this product at least once a month.

Flexi hot dog is made up of Mung beans, cattle blood, pork intestine as casing along with some spices. These ingredients are high in nutrients such as carbohydrates, protein, dietary fibre, haem iron, and are low in fat. To adhere to the flexitarian diet concept, the product developed contain as little animal ingredients as possible. The two test products were created with minor variations in the amount of animal ingredient. Since the new food products developed must meet the sensory expectations of consumers, the two test products have undergone sensory evaluation using a nine-point hedonic scale. The sensory evaluation results are promising, as panel members enjoyed the sensory attributes of the product developed.

To find the possible consumer and market prospects of flexitarian products, panel members answered market research survey questions. Panel members critically expressed their views as they see flexitarian diet as an easier option than strict vegan diets, and they would be interested to purchase this flexi hot dog at least once a month. These results are very valuable that in future flexitarian food products would have good market prospects since consumers showed significant interest. The Flexi hot dog nutritional composition was calculated using Swedish food agency data base. The Flexi hot dog has good amounts of protein, fibre and minerals like calcium, potassium and magnesium, high in fibre, and low in fat. By considering the Nordic nutrition recommendations, the flexi hot dog provided good amounts of carbohydrates and 50% of recommended daily intake of iron per 100 g of sausage. The carbon footprint of the flexi hot dog was low, about 1.3 kg CO_2eq/kg, which is low compared to meat sausages and similar to vegan sausage. The findings of this study showed that the flexi hot dog may have good market prospects, as consumers showed interest to buy this product for its good taste, because it provides both animal and plant nutrients, as well as has low influence on the environment.

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Abbreviations

BBC	British broadcasting cooperation
CF	Carbon footprint
GHG	Greenhouse gas emissions
IDA	Iron deficiency anaemia
NFA	National food agency
NNR	Nordic nutrition recommendation

1. Introduction

This chapter discusses diets and their climatic impacts in general provide a brief overview of the flexitarian diet and why it is beneficial and explains why this project intends to create a flexitarian food product.

1.1. Dietary changes for a better future

Food production is the leading source of global environmental change, accounting for up to 30% of global greenhouse gas emissions (Johansson & Torstensson , 2020). Significant reductions in total greenhouse gas emissions are necessary across all industrial sectors, but it is apparent that emissions from food systems must be addressed. Increasing wealth, growing urbanization, and a lack of access to healthy food are all factors that have contributed to the global move toward diets that are extensively processed, animal-based, and heavy in calories. Reducing our consumption of animal-based foods would improve both the environment and public health (Johansson & Torstensson , 2020).

As per the United Nations, the global population will reach 9.8 billion by 2050 (United Nations Department of Economic and Social Affairs, 2017). This is an almost 30% growth over the existing population of 7 billion people. Changing demographics and population expansion indicate an increase in demand for animal products, notably meat, dairy products, which providers must meet. Milk and meat output are predicted to grow by 58 and 73%, respectively, by 2050 (Bingli Clark Chai, et al., 2019). It has been established that no food group has a bigger environmental impact than the production of meat and dairy products, and their contribution to the climate accounts for around half of the present climate impact from Nordic food consumption. According to the Environmental Protection Agency's national numbers, combined meat and dairy products provide around 40% of the climate effect of the diet in Sweden (Nordic co-operation, 2014).

According to Riksmaten a Swedish Food Agency survey, the majority of the Swedish population does not consume enough whole grains, fibre, fruits, and vegetables. Consumption habits, on the other hand, indicate an oversupply of sugar, salt, saturated fats, and unhealthy snacks such as sweets, soft drinks, and pastries. For instance, the bulk of saturated fat originates from animal sources (Amcoff, et al., 2012). Shifting away from meat-heavy diets and towards more plant-based diets is widely seen as helpful to both planetary and human health. The negative effects on environmental sustainability, animal welfare and human health are frequently cited as the primary reasons for lowering meat production and consumption. As a result, plenty of studies have emphasized the critical need for a dietary shift away from animal-based, particularly red and processed meat diets toward more plant-based diets which have more vegetables, fruits, and pulses. This has resulted in the current scenario, in which scientific circles have reached broad agreement on the sustainability and health advantages, as well as the ethical qualities, of a diet low in animal-derived foods and rich in plant-based foods (Sijtsema, Dagevos, Nassar, Winter, & Snoek, 2021).

1.1.1. The emergence of the flexitarian diet

Reducing our use of meat products is critical to this protein transition, particularly in rich-world consumer diets, which are characterized by excessive consumption of animal products, such as meat is much above dietary requirements. Flexitarian diet enters the picture in a nutritional transition in which lowering total meat intake and substituting meat products with plant protein products are critical, but it is not required to become fully vegetarian and cease eating meat entirely. The two R's of reducing and replacing are combined into flexitarian, which may be described as a food consumption pattern in which meat is consumed on occasion but not entirely avoided. In contrast to the traditional interpretation of flexitarian, which began with vegetarianism, a flexitarian is a vegetarian who occasionally consumes meat (Dagevos, 2021).

In contrast to vegetarians who follow a meat-free diet and vegans who follow a strictly plant-based diet and abstain from consuming all animal-based foods, flexitarian means meat reduction on a part-time basis, and by the same token, a flexitarian allows eating meat occasionally without abandoning meat completely. Similarly, a meat-reduced diet is essential in the definition of the cognate concept of reducetarian, which is defined as a person who intentionally reduces his or her consumption of meat (Dagevos, 2021).

Because of core views and connections to animal-based foods and societal expectations, it is hard to fully shift from a carnivore diet to strict vegetarianism

or veganism; however, switching to a flexitarian or semi-vegetarian diet mainly plant-based, with limited meat consumption becomes less stringent and can still have an implication (Grasso & Jaworska, 2020).

Although the degree of meat reduction remains subject to interpretation, a low-meat flexitarian diet has lately been regarded as most useful in bringing co-benefits to the large health and environmental challenges we face. This corresponds to a flexitarian diet as an important dietary change that contributes substantially to minimizing the environmental impact of the food system while also providing more healthy diets and nutritional content to consumers. According to a recent increase in research on flexitarian's conducted in Finland finds that 13% of participants have made a shift toward less meat and more vegetable consumption in the last year, while 39% of consumers reveal that they are in midst of a change towards decreasing their meat intake behaviour (Dagevos, 2021).

United States does have the world's fifth highest per capita meat intake. According to the 2015–2020 Dietary Guidelines for Americans, meat intake in the United States surpasses healthy limits by 20–60% (Neff, et al., 2018). However, the study also revealed that a large percentage of participants (66%) reported lowering meat intake, particularly red processed meat. Over a three-year period, two-thirds reported lowering their meat consumption at least in one category, with red and processed meat being the most often reduced. The most prevalent reasons for the decrease were cost and health, the environment and animal welfare trailed behind (Neff, et al., 2018).

Flexitarians entails a little dietary modification in meat consumption for many modern food consumers. Choosing this consumption change pathway does not always result in significant meat limits and the adoption of a low-meat diet (Neff, et al., 2018). Practically, flexitarians abstain from eating meat several days per week, reflect that their eating meat has lowered and convey motives to potentially reduce meat consumption, or proclaim that they have a favourable attitude towards that plant-based diet. Although flexitarians are not a homogeneous consumer group, they do share the desire to limit their meat consumption to some extent. Although flexitarians' reasons for adopting more meat-free behaviours may vary in type and degree, studies correctly affirm that incentives for reducing meat consumption have lately received greater attention in comparison to possibilities and capability. That the majority of flexitarians still eat meat three times a week, in general, indicated that self-identified flexitarians eat meat regularly and seldom deviate from routinized meat consumption patterns (Sijtsema, Dagevos, Nassar, Winter, & Snoek, 2021).

1.1.2. The creation of flexitarian food product

Product development is a broad topic that is frequently discussed in the developing world. Creating sustainable and ethical products becoming a fundamental societal demand. A sustainable product is one that delivers environmental, social, and economic advantages while safeguarding human health and the environment throughout the product's life cycle (Paranagama, Wickramasinghe, Somendrika, & Benaragama, 2021). Consumer demand for a year-round supply of high-quality, diversified, and creative food items is increasing because of different lifestyles, increased incomes, and consumer awareness (Guiné, Ramalhosa, & Valente, 2016). Vegetarian and vegan dietary habits may be accessible due to the variety of food alternatives available and the various causes that push individuals to pursue such practices (Paranagama, Wickramasinghe, Somendrika, & Benaragama, 2021).

To popularize the notion of a flexitarian diet and make it a dietary option food pattern, this project attempted to develop a flexitarian food product with more plant-based components and minimal amounts of animal-derived ingredients. We opted to develop the Flexi hot dog with a higher portion of Mung bean, small quantities of cattle blood and pork intestine casing. The product encourages people to acquire balanced nutritious ingredients from plants and animals, which is the concept of a flexitarian diet. There is reason to be hopeful about flexitarian diet, because making progressive changes in eating habits needs less work than adopting a strictly plant-based diet and is thus more readily acceptable to a larger proportion of consumers. A step-by-step approach is certainly an effective behavioural method for encouraging people to change their food habits (Dagevos, 2021). Considering developing a flexitarian product will be a wonderful place to start to support and promote this approach to consumers who are flexitarians and the ones who want to become flexitarian.

1.2. Aim of this Product development

The purpose of this study is to develop a flexitarian food product called "Flexi hot dog" made up of mung beans, cattle blood and pork intestine as casing. This study will also analyse four aims:

- To evaluate sensory elements of the Flexi hot dog product.
- To analyse the consumer perception of flexitarian diet and Flexi hot dogs.
- To calculate the nutritional benefits of the Flexi hot dog.

- To estimate the carbon footprint of the Flexi hot dog.

1.2.1. Research question

- Does the product delight consumers in terms of sensory aspects? Which of the two recipes is preferred by the panel members?
- Is the flexitarian diet appreciated by consumers, and what do they think about it? Are consumers willing to buy this product?
- Does it meet nutritional requirements? What difference does it have from vegan sausage in terms of nutrients?
- Does this product have a good influence on the environment compared to vegan and meat sausage?

2. Background

This chapter provides a brief summary of the benefits of a flexitarian diet from various perspectives, and the driving forces behind the development of flexitarian food products as well as an introduction to the chosen methods.

2.1.1. Flexitarian diet from a nutritional standpoint

Prof. Walter Willett says that Transformation to healthy diets by 2050 will require substantial dietary shifts. Global consumption of fruits, vegetables, nuts and legumes have to double, and consumption of foods such as red meat and sugar have to be reduced by more than 50%. A diet rich in plant-based foods with fewer animal source foods confers both improved health and environmental benefits (Eat-Lancet, 2019). Eat lancet report also discusses their target 1 to achieving healthy diets and emphasize more about flexitarian diet as best example of planetary healthy diet. It recommends Scientific targets for a planetary health diet, with possible ranges, for an intake of 2500 kcal/day. Macronutrient intake is possible range up to 811-232 gm to kcal per day. This can be viable by adopting whole grain diet by utilizing rice, wheat, corn and other grain varieties, a modest number of animal protein sources a fair share of beef, lamb and pork Chicken and other poultry eggs, fish (Eat-Lancet, 2019).

2.1.2. Development of the new flexitarian food product in response to rising flexitarians

Flexitarian diet presence is beneficial from the standpoint of a sustainable and nutritious diet. It is unsurprising that a flexitarian diet has gotten increased attention recently, given that it is seen as an essential strategy to reduce the health and environmental cost of our food choices (Dagevos, 2021). According to a study published in the scientific journal Nature, switching to a more plant-based flexitarian diet might cut greenhouse gas emissions by up to 52% compared to baseline forecasts for 2050 (BBC, 2022). Expectations have indeed been raised since a flexitarian diet is thought to be a reasonably simple dietary change to undertake. (Dagevos, 2021). According to a market research survey conducted in the UK, customers are becoming more and more flexitarian. While almost 90% of

consumers consume red meat or poultry, more than a third (34%) of meat and poultry consumers regularly abstain the meat consumption (Grasso & Jaworska, 2020).

This rising trend toward eating of more plant-based foods has motivated to produce more meat alternatives in the market companies that are constantly trying to produce new food products. Meat substitutes, such as tofu and textured soy protein products, have been available in the Western world since at least the 1960s, but it appears that the target market has shifted from niche to more mainstream, with food products created explicitly to appeal to meat lovers (Curtain & Grafenauer, 2019).

The concept of hybrid meat products, which are meat products in which a portion of the meat has been partially replaced by more sustainable protein sources, may be suitable for bridging the gap between meat and meat-free products while providing convenience and allowing for more sustainable protein sources (Grasso & Jaworska, 2020). Many highly processed products available are already hybrid, as they may not always contain 100 percent meat. In the United Kingdom, for example, the Meat Products Regulation requires only 42 percent pork to label sausages as pork sausages, and the pork meat used can contain up to 30 percent fat and 25 percent connective tissue. The meat industry has used plant-based components from soy and wheat to save costs as well as for their functional uses, such as their capacity to emulsify fat, make food gel, and bind water. In hybrid meat products, this notion is pushed further to include positive attributes on the meat extension, including overall health, reduced environmental impact, and typically the idea of decreasing meat consumption (Grasso & Jaworska, 2020).

Hybrid meat products have the potential to create new business opportunities for the food industry, and they have only recently begun to appear on the market. The meat industry may be responding to growing flexitarian consumer needs, but the introduction of hybrid meat products may also represent a moment of transition and an attempt by meat manufacturers to gain market share over new popular plant-based alternative protein sources (Grasso & Jaworska, 2020).

2.1.3. The 9-point hedonic scale

Over the years, the role of sensory assessment has shifted dramatically. It assists in the formation of competitive strategy in collaboration with research and development and marketing divisions. Sensory testing may aid in the early phases of product development by identifying the critical sensory features that drive acceptance. It may be beneficial for identifying target customers, and product

rivals, and evaluating novel concepts (Sharif, Sharif, & Sharif, 2016). The 9-point hedonic scale has been chosen to evaluate sensory characteristic of flexi hot dog which is most widely used scale for measuring consumer choice and acceptability of food products since its establishment. The scale's creation, which began in 1947 at the Quartermaster Food and Container Institute for the Armed Forces, was driven by the need for a rating scale that could surpass the constraints of the time-consuming paired comparison approach. The developers adopted the graphical rating scale, which experimental psychologists had previously used to quantify a variety of psychological phenomena, to assess the "hedonic value" of foodstuffs (Lim, 2011).

The 9-point hedonic scale is a balanced bipolar scale with four positive and four negative categories on each side, cantered on neutral. The categories are labelled with sentences representing varying degrees of impact, which are grouped sequentially to depict a singular range of likes and dislikes. The characteristics are designed to assist not just participants in responding appropriately, but also experimenters in interpreting the mean value of replies in terms of the degree of likeability and disliking (Lim, 2011). The fundamental reason for the 9-point hedonic scale's widespread popularity is that, as compared to alternative scaling methods (e.g., magnitude estimation), its categorical structure and restricted options make it simple to use for all study participants and researchers. Because of its convenience, the 9-point hedonic scale is ideal for usage by a wide range of people without considerable training (Lim, 2011).

The 9-point hedonic scale is also simpler than other programs that require tracing lines or documenting magnitude estimates that may contain fractions; however, this practical consideration is becoming less important as computer programs get more sophisticated. More importantly, it has been demonstrated that basic category scales have the same discrimination strength as other scaling approaches e.g., line marking and magnitude estimation as a result, when evaluating hedonic variations among meals, beverages, and consumer items and forecasting their acceptability is the major goal of a study, the 9-point hedonic scale has shown to be a simple and effective measurement technique (Lim, 2011).

2.1.4. Consumer research

Before the millennium, the food business in the EU began to recognize the growing significance of food products' functionality, which accelerated the emergence of new products. However, there was a significant failure rate for new items: it was predicted that at least 75% of recently introduced functional food products were pulled off from the market within the first two years since the majority of them were not preceded by a more thorough examination of consumer

demands (Szakos, 2022). Consumer Behaviour is a fascinating research topic of human behavioural science with the goal of understanding what consumers want, why they think the way they do, and how to market the products to them. Consumer attitudes determine their behaviour and influence their purchases. Understanding consumer attitudes and behaviour is therefore critical for dealing with markets and customers more effectively. The attitude toward behaviour idea explains the decisions made by customers, as well as their behaviour (Le, 2019).

Consumer opinions regarding a new product or a new product concept are gathered through surveys used in new product market research. The product might be anything from a small, everyday item like food or a toy to a larger one like a television or kitchen appliance. No matter how big or little the product, the management of the new product market research survey will proceed in the same way (DeFranzo, 2022). Open ended survey question is chosen to evaluate consumer preferences of flexitarian diet and the flexi hot developed. In the open-ended survey questions respondent is given the freedom to provide an answer of any length or subject. Therefore, this type of surveys that can bring out detailed feedback. Sometimes this method can be not progressive since some people could have a bias to respond and leave with a single word. However, there are several other huge advantages that help your feedback gathering be more insightful and provide better guidance for future initiatives (Drag n survey, 2022).

2.1.5. Nutrient assesment

Nutritional analysis is an important step Measures of nutritional status are typically useful because they can predict health consequences. The practical requirements for assessing nutritional adequacy give rise to the need to intervene, either through advice or more aggressive strategies, to improve the nutrition of individuals or populations, thereby reducing the risks and burdens of diseases that have, or may have, a nutritional component. (Bates, Bogin, & Holmes, 2021).

In order to analyse nutrient composition of flexi hot dog Swedish food composition database is used which is openly accessible and highly trusted for its quality and is widely used in the field (Livsmedalsverket, 2022). The Swedish Food Composition Database contains nutritional information for over 2000 foods and cuisines, the majority of which are Swedish. The primary goal was to give nutritional information on typical items on the Swedish market and to allow the National Food Agency to calculate energy and nutrient intakes using NFA diet surveys. The data prioritizes nutrients listed in the Swedish nutritional guidelines. The ultimate purpose of this database is to do nutrient calculation and largely used by food industries for analysis to use for recipe creation and product development, for diet planning, planning menus, food production and control, educational

purpose and information for research in different sectors (Bruce & Bergstrom, 1987).

2.1.6. Carbon footprint assesment

Currently, the environmental consequences, particularly the carbon footprint of food choices have received attention, and it has been argued that changes in eating habits can drastically influence an individual's personal carbon footprint. (ÜÇTUĞ, GÜNAYDIN, HÜNKAR, & ÖNGELEN, 2021). Reduced greenhouse gas emissions and primary energy usage are essential steps for long-term processed food production and the expansion of food processing firms. The carbon footprint of a food product is the total quantity of GHG emitted over its lifetime, expressed in kilograms of CO_2-equivalents. As consumers grow more aware of the need of choosing low-impact food options, it is becoming increasingly important to quantify the carbon footprint of food items. Hence it is essential to calculate the carbon footprint of flexi hot dog in order to validate its environmental impact (Singh, V, V , & Arora, 2018).

3. Materials and Methods

This chapter discusses the method and materials used in the study briefly, beginning with a flow chart depicting the steps involved, idea generation, and the benefits of the selected ingredients. This is followed by a description of the test product's production and the four methods used in the study, as well as their limitations.

Figure 1*: outline of the steps involved in this project*

3.1.1. Product development

Figure 1. shows the steps involved in a classical product development for a food product. Idea generation is a creative process often innovative, and methodological. Product development emerges from knowledge of the customer, the market, technology, and the general environment, and it generates newness in product, manufacturing, and marketing. It generates product concepts in a methodical manner to meet the project's goal and, as a result, the business strategy. The scope of idea creation is maintained broad to ensure that no potential breakthroughs are overlooked, but it is narrowed to fit the project's goals (Earle, Richard Earle, & Anderson, 2017).

The objective of this research is to create a flexitarian food product that complements and supports flexitarian diets and the individuals who adhere to them. As a result, this study has chosen to produce a product that people are most likely to consume. Sausage is one such product, and it is available in both plant-based and meat-based varieties. Mung beans were chosen as the primary plant-based component in Flexi hot dogs. Cattle blood and pork intestine casing are the second most important components that fulfil animal-derived ingredient requirements and the rest of the spice's onion powder, garlic powder, cayenne chilli, Italian seasoning mix, and salt are used to enhance the flavour. The ingredients used to prepare flexitarian sausage are carefully picked to meet objectives such as nutritional advantages, low environmental impact, and appealing sensory features.

3.2. Characterestics of ingredients

3.2.1. Mung beans

Many health organizations throughout the world have advocated for increasing consumption of plant-based diets to promote chronic disease prevention and general human health. As an outcome, a wide range of plant-based functional meals have been included in healthcare programs. Mung bean [Vigna radiata (L.)], is one such bean that has shown health advantages. Mung beans are classified as a legume. It is high in calories, protein, and other essential elements. Mung beans are often consumed cooked, either in a soup or crushed into flour for breads and noodles. Many Asian nations, as well as drier sections of southern Europe and warmer parts of Canada and the United States, produce this crop (Yi-Shen, Shuai, & FitzGerald, 2018). People benefit from the vitamins and minerals found in mung beans in three ways. They promote bone, blood, and blood pressure health. Strong bones and healthy blood that carries oxygen to all of the body's cells may benefit anyone at any age. Finally, adults can benefit from maintaining a healthy blood pressure level (Kowalewska, 2018).

Mung bean has long been used as a food and feeds source for humans and animals due to its high nutritional value, particularly in the seeds. Mung bean seeds have a protein level of around 20.97–31.32 percent, comparable to 18–22 percent and 20–30 percent in soy and kidney beans, respectively. Furthermore, the protein content of mung bean seeds is around twice higher as that of cereal seed maize, with a lower storage protein content (7 to 10%) and much higher protein content than that of typical root crops. Mung beans were chosen as the main component

due to their high nutritious content and a wide variety of health benefits (Yi-Shen, Shuai, & FitzGerald, 2018).

Mung beans are high in vitamins like B6, K, and folate, as well as minerals like calcium, iron, magnesium, phosphorus, and potassium. Mung beans, in addition to these vitamins and minerals, are a good source of plant protein. Mung beans have a protein content of 23 g per 100 g (Kowalewska, 2018). As a result of their high protein content and digestibility, mung bean seeds combined with cereals have been advised to considerably boost the quality of protein intake as part of a vegetarian diet (Yi-Shen, Shuai, & FitzGerald, 2018). Mung beans are chosen as key plant-based ingredient after considering its nutritional quantity and health benefits. Mung bean is rarely used in sausage making. Several common ingredients were also eliminated, including soy and peas, which usually go into sausage production and vegan food production because of concerns regarding their detrimental environmental impact upon cultivation (Paranagama, Wickramasinghe, Somendrika, & Benaragama, 2021).

3.2.2. Cattle Blood

It is said “Everything at the slaughterhouse may be used except the last cry of the animal,” This assertion is reasonable (V.V.Kulkarni & Devatkal, 2022). It is no longer feasible to discard by-products, fact that many valuable by products have a high market prospect, thus, the development of new products and functional components utilizing high-value animal by-products will be beneficial. (V.V.Kulkarni & Devatkal, 2022).

Animal blood is the first by product that comes from the slaughterhouse, it contains a high concentration of protein and heme iron and is a valuable food by-product. 80.9 percent of bovine blood is water, 17.3 percent protein, 0.23 percent fat, 0.07 percent carbohydrate, and 0.62 percent minerals. Animal blood has long been used to produce blood sausages, blood pudding, biscuits, and bread throughout Europe. As an example, black pudding is a traditional Swedish delicacy made in all Swedish households However, it may be considered inedible in other nations and hence have a much lower value. India has prohibited the collecting and use of killed animal blood for human use (V.V.Kulkarni & Devatkal, 2022).

Blood is chosen as the principal component that provides animal-based derivatives in flexitarian sausage due to its nutritional value being rich in heme iron and being a resource efficient option. Blood is very popular and well-known among the Swedish people; thus, it is an excellent choice for use in flexitarian

sausage. After considering the environmental implications and the large choice of meat sausages readily available on the market, red meat is carefully avoided.

3.2.3. Pork Intestine as natural casing

Casing selection is a critical stage in the manufacturing of sausages with specific features. The casing is an essential component of sausage, isolating it from its surroundings and allowing it to function as an independent state. Its function, however, cannot be limited to just supplying the form, size, and integrity of the sausages. The role of sausage casing begins with filling and finishes at the customer table. The casing influences the volumetric, structural, and chemical changes that occur in the sausage during the manufacturing phases in both direct and indirect ways (Djordjevic, et al., 2015).

As the world's population has grown, several meat processors have shifted to mass manufacturing at low costs. Collagen and cellulose casings, often known as artificial casings, are being designed to fulfil the rising population's requirements (QMS, 2010). The more selective purchaser, on the other hand, prefers higher-quality sausages with unique combinations and excellent flavour, texture, and origin. As a result, in order to keep competitive in the industry, premium processors continue to retain a sizable market for natural casings. Although natural casings are more expensive, some think they are worth the extra cost because of their superior texture and eating quality. Processors might command a higher price for the greater added value (QMS, 2010).

Natural casings are sturdy enough to withstand pressure during filling, permeable to water vapour, gases, and smoke, elastic, and maybe tied or clipped at the end of the sausage. This casing is commonly used in the manufacturing of traditional fermented sausages. Depending on the type of casing required, one or more of the intestinal layers are removed during the natural casing manufacturing process. Removing layers improves permeability and elasticity while decreasing casing resistance properties. Processing of intestine for casing manufacturing should begin as soon as feasible after slaughter, particularly while the tissue is still warm, to minimize bacterial deterioration, which happens fast, and to allow for simpler removal of mesentery and fat. The submucosal membrane that remains after processing is mostly connective tissue, and it is robust, elastic, and edible. Sheep, goats, and pig's tiny intestines are often utilized as small-diameter casing (Djordjevic, et al., 2015).

The pork intestine provides some animal nutrients and is well acknowledged for its superior quality and distinctive flavour, is used as the casing for the Flexi hot dog. The nutrient content of the pork intestine has protein contents 11.74 and 7.71 grams for small and large intestines respectively, fat contents were 7.55 and 13.44

grams, and cholesterol contents were 171.95, 122.60 grams, respectively. The small intestine has 51.28 percent unsaturated fatty acid, whereas the big intestine had 55.22 percent (Jeon, Kim, Kim, Shon, & Lee, 2010). Another important purpose for choosing pork intestine casing is to see how good it tastes with a combination of mung bean and blood in it. Because the natural casing is mostly utilized for traditional fermented beef sausages. As the natural casing is also being used less frequently because of rising costs and more expensive production procedures. We aimed to employ natural casing to promote the use of animal derived casings.

3.3. Production of test product

This section explains the production methods of flexitarian sausage in detail right from the procurement of raw materials, two recipes created flowchart that explains cooking steps involved in the making of flexi hot dogs. Pictures of the process can be seen in appendix 6.4.

3.3.1. Procurement of raw materials

The main components in this flexitarian sausage preparation are mung bean, cattle blood and pork intestines used as the casing of the sausage. Other minor ingredients garlic powder, onion powder, rosemary, cayenne chilli, Italian seasoning, and salt were utilized as spice powders. All the ingredients were obtained at a local grocery store, apart from the pork intestine sausage casing, which was purchased and delivered from the Lundgrens skafferi website.

3.3.2. Making of the experimental product

Experimental design is a factorial design that is developed to set up the selected attributes. Prototypes developed are handled with substantial flexibility by a product developer. Making an experimental product is a very crucial part of new product development (figure 1) because in this case only all attributes framed should be given proper attention and also the possible space given to the variability is spanned by the number of resources provided. The main goal of developing experimental products is to create the best product and to make use of product developers' creativity and experience as best as possible (Naes & Nyvold, 2003).

Following the purchase of raw materials, the first phase in product development was the creation of two trial prototypes subsequently named as Recipes 1 and 2. The amount of mung beans is kept high while the proportion of blood is kept as low as feasible. To make this experimental product development as basic as possible, artificial flavours, preservatives, colours, stabilizers, protein powders, and starch are purposely avoided. The aim was to keep the product free of any additives.

Recipe 1 has 220 g of mung bean and 30 g of cattle blood, whereas Recipe 2 contains 200 g of mung bean and 50 g of cattle blood. The remaining ingredients are used in identical amounts in both recipes. The goal of prototype development is to use as much mung bean as possible while using as little blood as possible. This difference in both recipes is intended to demonstrate the varying degrees of likeability of panel members who taste the product during sensory evaluation. Finally, the product was made experimentally using selected components, and ingredients were modified based on the recipes. The following sections explains each step of flexi hot dog recipe in detail.

3.3.3. Recipe

This section gives the detailed steps of whole preparation steps of sausage making.

Table 1: *Ingredients used in recipes 1 and 2 for a flexitarian hot dog, original amounts and up-scaled to 1kg sausage*

Raw materials	Recipe 1	Recipe 2	Recipe 1 for 1 kg of sausage	Recipe 2 for 1 kg of sausage
Mung bean	220 g	200 g	448 g	408 g
Cattle blood	30 g	50 g	61.2 g	102 g
intestine	15 g	15 g	30.6 g	30.6 g
Spices	15 g	15 g	30.6 g	30.6 g
Water to be added	210 ml	210 ml	428.8 g	428.8 g
Total weight	490 g	490 g	1000 g	1000 g

The table 1 shows the quantities of various ingredients used in both recipes and recipes for making 1 kg of sausage are also produced and presented in tables. The major reason for providing an upscaled version is to calculate the nutritional

content of 1 kg of sausage and to calculate carbon footprint calculations. Because 1 kg of food products is the most usual way of making these calculations.

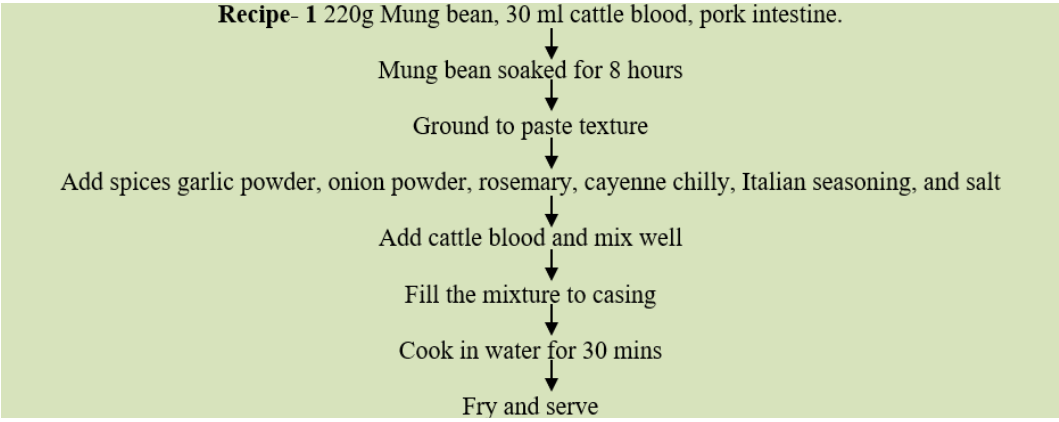

Figure 2: *The recipe 1 preparation steps*

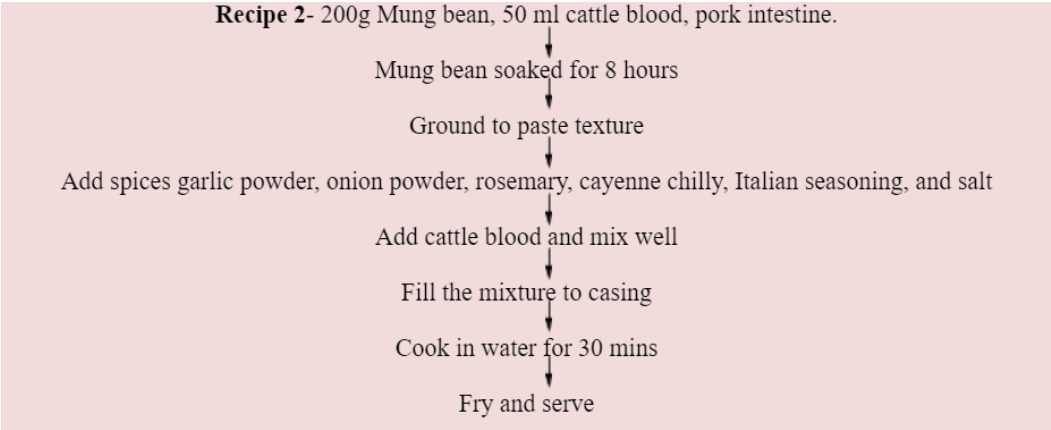

Figure 3: *The recipe 2 preparations steps*

Figure 2 & 3 shows the preparation steps for recipe and 2 first, the desired amount of Mung beans were washed and soaked in water for 8 hours. The soaked mung beans were ground into a paste in a mixer with spices (garlic powder, onion powder, rosemary, cayenne chilli, Italian seasoning, and salt). Now the Cattle blood was added, and mass was stirred thoroughly to mix all ingredients. Now, the pork intestine casing were thoroughly washed and drained in cold water. The sausage mixture was then inserted into the casings, and the ends were hand-knotted together. Once the stuffing was completed, the sausage were boiled in water for around 15-20 minutes and before serving the sausages was fried in cooking oil. The below pictures figure 4 and 5 shows the finished sausages.

Figure 4 : *Experimental product of recipe 1*

Figure 5 : *Experimental product of recipe 2*

3.4. Sensory evaluation

The objective of the flexitarian sausage development is to learn about panels' impressions of Flexi hot dogs to learn about how consumers perceive the taste of the product. The 9-point hedonic scale is used to determine this. The Chosen Attributes are bean taste, meaty taste, juiciness, tenderness, spice intensity, and overall impression (appendix 6.1). Students, research faculty, and preschool teachers were among the 30 persons who were interested in and able to participate in the sensory evaluation. Panel members were asked to taste two slices of cooked sausage from the two different recipes, and the findings were recorded on printed

papers that depict hedonic scales with both numbers and points with selected attributes appendix 6.1 gives table of 9-point hedonic scale which is given to panel members.

3.5. Consumer research survey

A survey research method was employed. It was the principal tool for collecting quantitative data. The questionnaire had seven simple structured and open-ended questions appendix 2 shows the survey question given to the participants. Participants' names and personal information are not disclosed in order to protect their privacy. It is an advantage to use a survey because it gives respondents an element of anonymity, which encourages honest and critical responses (Mammadli, 2016). Participants are requested to answer structured open-ended survey questions in addition to the sensory evaluation in order to understand more about their perspectives regarding the flexitarian diet and product. Dimensions of the survey questions included respondents' demographic characteristics such as their age, gender, country of origin, whether they have any dietary preferences, whether they prefer vegan or flexitarian diets, what their impression is of flexitarian diets, and whether they would be interested in buying flexitarian food products on the market.

3.6. Nutrition assessment:

After careful examination of the approach, this study chooses to utilize the Swedish food composition database (Livsmedalsverket, 2022), only major components such as mung bean, cow blood, and pork intestine casing were nutritionally evaluated. Other small minor ingredients, such as spices, have been excluded because the amount utilized is minimal. Appendix 6.2 shows the nutrient content of each ingredient.

3.7. Carbon footprint analysis

The goal of this study was to calculate the carbon footprint of flexitarian hot dogs per kilogram. In order to calculate the carbon footprint of Flexi hot dogs, the carbon footprint reference values for each ingredient were gathered from studies that have done carbon footprint analysis (table 2**)**. They are then determined based

on the amount of ingredients required to make 1kg of Flexi hot dog preparation. There were certain constraints during this computation, such as the fact that a few ingredient values had not been calculated previously, thus those ingredients were compared to comparable ingredient which is processed in a similar way.

Table 2: *References used in the carbon footprint analysis for various ingredients used in the development of flexi hot dog.*

Ingredient	Reference value [kg CO2e/kg]		Remarks	Reference Article
Mung beans	Dry lentils	0.6	It was difficult to find the CF value of mung beans, thus they were compared to the CF value of dried lentils because both ingredients are processed in almost identical ways and imported to Sweden.	(Potter, Lundmark, & Röös, 2020)
Beef blood	Beef Blood	8	The CF value of blood was based on economic allocation of different meat cuts of Swedish beef.	(Scholz, 2013)
Pork intestine	Pork Organ meat	3.1	The CF value of organ meat was based on economic allocation of different meat cuts of Swedish pork.	(Scholz, 2013)
All spices	Cayenne pepper	1.6	Since it was hard to find the CF value of each spice, hence the spices used in the entire recipe were compared to the Cayenne pepper value.	(Marie, 2022)
Rapeseed oil	Rapeseed oil	2.9	The CF value of rapeseed oil is found on a heal label website.	(Marie, 2022)
Tap Water	Water	0	The CF value of water is taken from LCA studies of Stockholm tap water	(Angervall, Flysjö, & Mattsson, 2004)
Energy use during the process	Electricity	0,029/kWh	This value is taken from website Nowtricity which gives Sweden energy CF value	(Nowtricity, 2022)

3.8. Limitations of chosen methods

The 9-point hedonic scale has been associated with several limitations despite its widespread usage in sensory research. First the scale can only produce ordinal or, at best, interval data due to the inequality of scale intervals and the lack of a zero point. As a result, the scale cannot give information regarding stimulus liking/disliking ratios, nor can it provide a fair comparison of hedonic perception between individuals and groups (Lim, 2011).

Several limitations were discovered during the consumer survey research process. For instance, the study was constrained to a particular geographic region around Uppsala, which limited its generalizability to identical surroundings. Second, data were gathered using a survey approach. Surveys, on the other hand, are often vulnerable to a restricted number of questions. There were only 30 people who participated due to time and source constraints. Hence it makes it more uncertain to compare to wider populations Furthermore, survey questions are incapable of uncovering the motivations behind a certain action or viewpoint (Mammadli, 2016).

Even though nutrient evaluation is limited to the Swedish database, other websites, and reference materials, the nutritional assessment provides some overall estimates of nutrients in flexitarian sausage. If the product is tested in a laboratory method of nutrient analysis, the accuracy of the value might range from high to low. One of the drawbacks in the carbon footprint estimation method, is that it relies on reference papers and webpages, and the inability to find some ingredients is encountered, so those ingredients are compared to those of other similar products processed similarly, hence it might affect the results.

4. Results and discussions

4.1. Sensory evaluation

This section provides results of sensory evaluation.

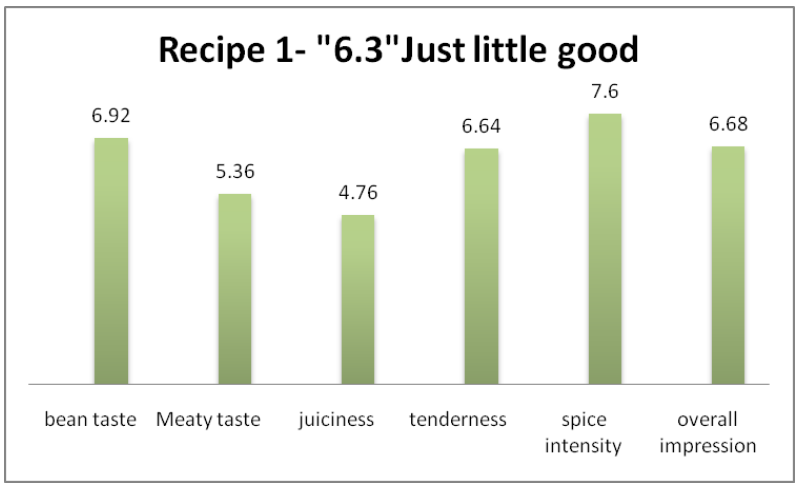

Figure 6: *The overall result of recipe 1*

Figure 7*: The overall result of recipe 2*

4.1.1. Bean taste

The above figure 6 and 7 shows the results of attribute 1 bean taste to both the recipes. The first attribute picked is bean taste because the mung bean is a prominent component of the product. As a result, the bean taste and flavour dominate the product. Hence it becomes essential to find out how the panel members rate the bean flavour and how much they appreciate it in relation to two different recipes. The average result for recipe 1 is 6.92, indicating that the bean flavour is liked moderately. The average value for recipe 2 is 6.42, indicating that the bean taste is liked slightly in recipe 2 (Figure 6). Therefore recipe 1 is liked better than recipe 2 for this attribute (Figure 7). The key takeaway from this finding is that recipe 1 has a larger bean content of around 220gm which is highly liked for bean taste, but recipe 2 has a little less, about 200gm of mung bean and blood is higher by about 50 ml, but the overall result is a positive good for both the recipe.

4.1.2. Meaty taste

The meaty flavour is chosen as the second attribute to test the panel members' perceptions of meat taste because the product does include small amounts of blood. The average result for recipe 1 is 5.36, indicating that the Meat taste is neither liked nor disliked (Figure 6). This shows that recipe 1 with more mung beans does not give a high meat taste, which is why this attribute has a relatively low value; whereas the average value for recipe 2 is 5.96, indicating that the meat taste is liked slightly in recipe 2 (Figure 7). Even though the amount of blood used is high is not that much dominating in the recipe, so the sausage overall does not give more meaty taste These ingredients changes have an influence on the panel's decision, but the overall result is acceptable, though a little good for both the recipe. This attribute result also shows that sausage doesn't give enough meaty taste in both recipes.

4.1.3. Juiciness

Juiciness was picked as the fourth attribute since it is also a distinguishing feature of meat sausage. Because the flexitarian hot dog contains blood, it is necessary to analyse this characteristic in order to learn more about the panel's view of this feature. Recipe 1 had an average rating of 4.76 dislikes slightly (Figure 6) while recipe 2 received a rating of 5.48 like slightly (Figure 7). This finding is highly significant since it shows that the sausage does not have a lot of juiciness and is very low. The recipe does not include any extra fat or oil, which makes the sausage less soft and hence both the recipes need further improvement.

4.1.4. Tenderness

Tenderness was picked as the third attribute since it is an essential characteristic of sausage. The average result for recipe 1 is 6.64 liked mildly (Figure 6), and the average result for recipe 2 is 6.92 liked moderately (Figure 7). Both results are almost similar, except the sausage contains more mung bean, which makes the sausage tougher and less soft. The important discovery here is that recipe 2 has a little more liked this demonstrating that a large amount of blood around 50 ml makes the sausage more tender, whereas less blood around 30 ml in recipe 1 makes the sausage a little tender. Overall, this is a good outcome for both the recipe.

4.1.5. Spice Intensity

Spice intensity has been selected as attribute 5. The flexitarian hot dog has spices to boost flavour. As a result, the purpose of this sensory evaluation is to assess the panel's liking of the spice used in sausage. The average result for recipe 1 is 7.6 (Figure 6), while the average result for recipe 2 is 7.2 hence recipe 1 is liked better in spice intensity (Figure 7). The overall result of both the recipe indicates that the overall outcome is very good. This result demonstrates that customers' impressions of spice are quite favourable, and it becomes the most rewarding result.

4.1.6. Overall Impression

overall impression is attribute 6 to learn about the panel members' general impressions of the sausage. Recipes 1 (Figure 6) and recipe 2 (Figure 7) received 6.8 and 6.7, respectively, because of the panel members' favourable responses to recipe 1. The overall impression of both the recipe is good.

4.1.7. The most liked recipe

The above Figures 6 & 7 show the result of both recipes and recipe 2 got a high average value "7" when counting all the attributes rating and shows that they are liked better than recipe 1. The attributes which got a high rating are meaty taste, juiciness, and tenderness. Even though bean taste, spice intensity and the overall impression are low. Yet recipe 2 has got higher value and makes it a highly liked recipe by panel members.

4.1.8. Final sensory analysis results

The key sensory assessment results demonstrate that flexitarian hot dogs lack softness and have very low juiciness. The dominant flavour in sausage is bean flavour since the main component is mung bean, which gives the sausage a strong bean flavour while also making it tougher. The one feature that received the most satisfying results was spice intensity; this indicates that the spices used in sausage are widely liked by panel members and were granted greater value to both recipes. The overall impression of sausage is favourable, indicating that consumers liked the sausage despite some small flaws. The overall rating of attributes shows that recipe 2 (Figure 7) which has a high amount of blood in it is liked better and got a high rating. This shows that recipe 2 is liked better than recipe 1 (Figure 6) by panel members. When flexitarian hot dogs are possibly introduced to the market, further improvement should be done to increase their juiciness and softness.

4.1.9. Discussion of sensory evaluation results

On the 9 points hedonic scale consumers are expected to evaluate a product and say how much they enjoy it. It is useful for designing menus and meals that are popular with many consumers may be kept on the menu, while those that are unpopular with many customers can be eliminated or improved to be better. The purpose here is not to compare the relative degree of liking amongst items, but rather to record if food is enjoyed sufficiently enough to stay on the menu and to improve its quality. The conclusions are more absolute than comparative (Wichchukit & Mahony, 2015). The overall results taken for Flexi hot dog are easy to compile and the findings are understandable to interpret the results when it comes to reflecting the consumer's opinion about two recipes and chosen attributes, results reflecting which recipe is liked better than the other and also an emphasis on which attributes did not meet consumers expectation and in lower value which must be improved for further development.

New products must first get general acceptance from the public. Consumer acceptability of niche products is predicted partly by sensory evaluation, which is affected not only by the sensory qualities of the product but also by persons individual characteristics. These can serve as either motivators or obstacles to adoption depending on the ethical considerations, political beliefs, and ecological welfare involved in the production (Fiorentini, Kinchla, & A. Nolden, 2020).

Considering the results from other studies which is explored to find the consumer acceptance using sensory analysis of hybrid produts which has blend of meat and plant ingredient, which is like flexitarian product developed in this study except the ratio of meat and plant ingredients (Caputo, Sogari, & Van Loo, 2021). US consumers participated in a research study that combined sensory evaluation and

distinct selection experimentations with four different types of burgers: a 100% beef burger, a plant-based burger produced with pea protein, a plant-based burger produced with animal-like protein, and a blended burger made with 70% beef and 30% mushroom. Before tasting the burgers, participants were either placed in a blind tasting condition and a condition where they were given knowledge about the components. The findings show that participants highly prefer beef burgers over alternatives irrespective of sensory conditions, blend burgers over alternatives in the blind condition, but demand and willing to pay declines when consumers are well informed about the blending, and plant-based burgers with animal-like protein over those with pea protein (Caputo, Sogari, & Van Loo, 2021).

When comparing preferences for the other three burger options, researchers discover that the blended burger is preferred second highest under blind tasting conditions when looking at willingness to pay and demand, but the second lowest in the knowing tasting situation when looked at the demand for the three other burger options. This demonstrates how the blend burger with 70% beef and 30% mushroom is preferable to the meatless options in the blind tasting. evidence from this study provides that even minor information can significantly change respondents views and choices. It also demonstrates the intriguing trade-off between Taste, flavor and information, as respondents generally seem to like the taste of the hybrid choice but prefer to entirely convert to the plant-based option once they realize they have already compromise on their meat consumption. (Caputo, Sogari, & Van Loo, 2021)

Hence the above mentioned study clearly depicts that consumer shows significant difference to their sensory expectations, and willigness to buy the product when they know about the necessary information of the products, hence the results of sensory anlaysis of flexitarian sausage cannot necessarility shows the consumers acceptance and willingness to buy this product in future eventough the product has good sensory outcome. the sensory evaluation is only confined to group with majority of students and proffessors who are aware of the flexitarian notion and their significant benefits, hence they have good overall impression for both the products in term of sensory expectations eventhough the sausage has minor defects. But these results cannot be same when sausages introduced in the market as the general public would have different views. Consumers who have already cut back on their meat consumption will switch entirely to plant-based options, even though flexitarian sausage contains low animal ingredients, they might select plant-based choice over flexitarian sausage.

4.2. Consumer research survey results

The market research was carried out by open-ended survey questions distributed to 30 participants, along with sensory evaluation. People were quite willing to share their true feelings in both the sensory evaluation and the market research survey.

4.2.1. Age group

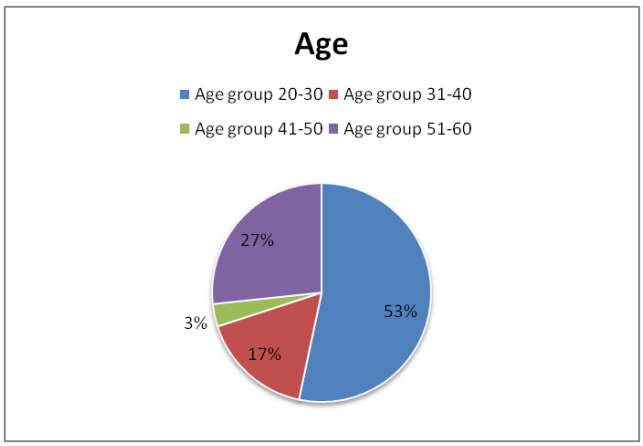

Figure 8 :*The results of age groups of panel members*

The first question in the market survey seeks to identify the age group of participants (Figure 8). The majority of participants (about 53 percent) are between the ages of 20 and 30, and the most of them were university students or students residing in Uppsala. The following age group, 31-40, accounts for around 17% of the panel members and is made up of teachers and students. Only 3% of those between the ages of 41 and 50 are university professors or preschool teachers, whereas 27% are between the ages of 51 and 60 is the same as university professors or preschool teachers. Since the market survey is confined to a small number of individuals, the majority of whom are between the ages of 20 and 30, this survey has chosen to focus on students, whose thoughts and opinions are important to obtain and may be compared to the bulk of the population.

4.2.2. Gender

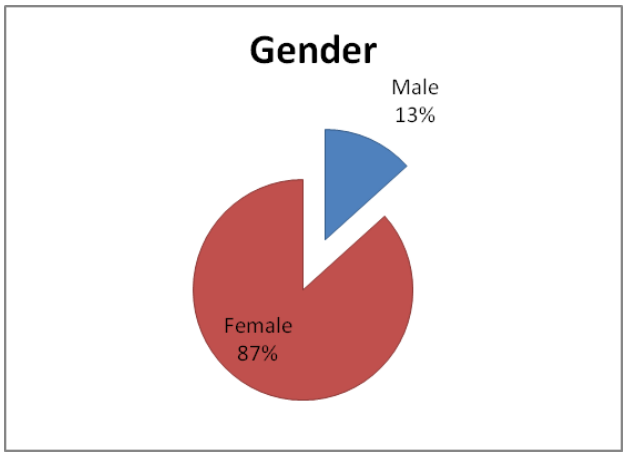

Figure 9: *The results of the gender of panel members*

The second question was about gender because it is important to identify viewpoints based on gender differences (Figure 9). The majority of the panel group is female about 87% whereas only 13 percent of males are participated. This includes students, professors, and preschool teachers.

4.2.3. Country of origin

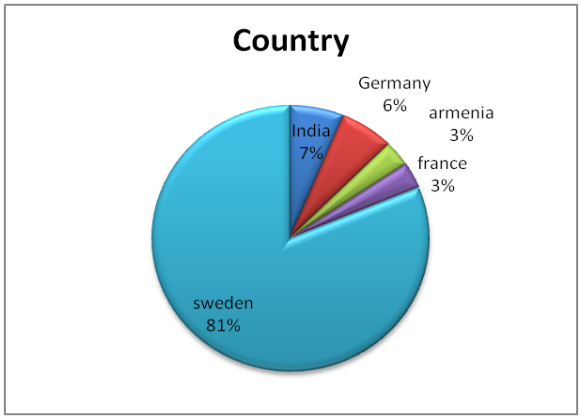

Figure 10 : *The results of the country of origin of panel members*

The survey questions also aim to discover people from the country of origin, which is an essential factor because people's attitudes differ depending on where they are from (Figure 10). The vast majority of them (81 percent) are Swedes. 7% from India, and the rest of 12 % from other European countries like France, Germany and Armenia.

4.2.4. Dietary preferences

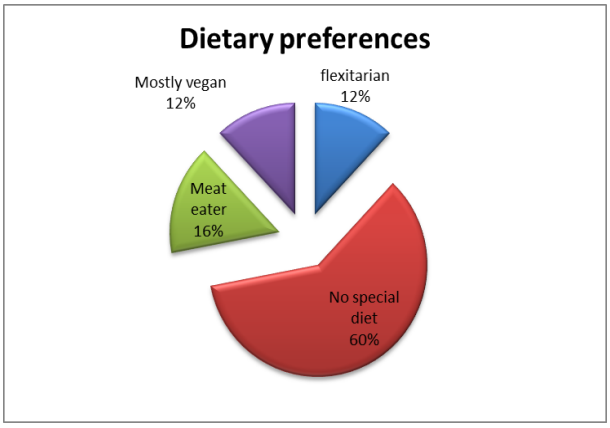

Figure 11: *The results of dietary preferences of panel members*

Participants in the survey were questioned if they follow any specific diets in order to determine if they have food preferences in general (Figure 11). As it was an open-ended question, participants provided their thoughts on diets in general and why they prefer and follow certain diets; they also revealed that they would like to follow different diets in the future for a variety of reasons. Approximately 60% of them stated that they do not currently follow any special diets. A few participants also stated that they normally buy locally produced food, foods with a minimal environmental effect, and they are attempting to minimize their meat consumption. 12 percent of the participants were represented themselves as flexitarians, and they also stated that they are highly observant about lowering their meat diet and attempting to eat plant foods on a regular basis. 16 percent of individuals identified as meat eaters or omnivores, and they were also unwilling to eat plant-based cuisine. 12 percent of participants stated that they are trying to be vegan most of the time, with a significant mix of vegetables and meats.

4.2.5. Choosing vegan or flexitarian

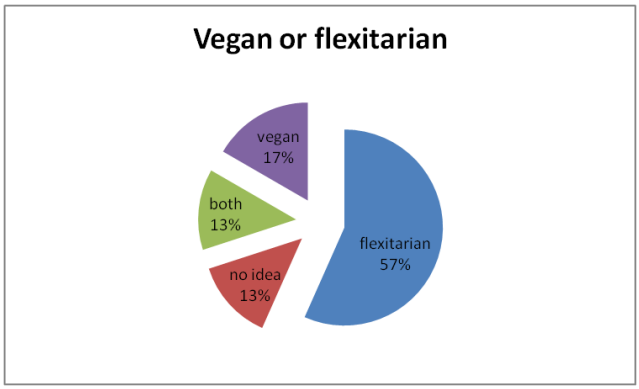

Figure 12: *The results of choosing best diet vegan or flexitarian*

Participants are asked which diet is better – a vegan diet or a flexitarian diet (figure 12). This was such an interesting question that participants have shared so many thoughts about their choice and they are very passionate about sharing reasons why they choose that particular diet over others. The majority of them about 57% said that flexitarian is better and many also shared so many thoughts about it, few told that it is easier than strict vegan diets, some chose flexitarian for health reasons, and some also said that flexitarian diet also has pro and cons, also left a question that how it can be a desirable strategy to future food systems. 17 % of them chose veganism as a better diet, and the other 13% of them chose they choose both diets are better and equal, and the rest 13% left the question that they have no idea about diets.

4.2.6. Opinion about flexitarian diet

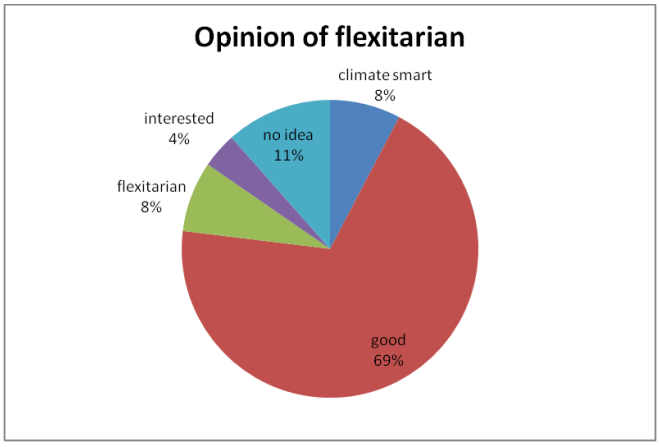

Figure 13: *The results of panels opinion about flexitarian diet*

The next most important question has been provided to the participants in order to discover their overall view and comprehension of flexitarian diets (Figure 13). The majority of them are well informed about flexitarian diets. Approximately 69 % said that a flexitarian diet is beneficial for health, a few responded that they are a good combination of both plants and meat, and a few also stated that they are ideal options for meat reducers. Only 8% of them acknowledged themselves to be flexitarians. And 4 % expressed an interest in following flexitarian diets. Another 8% of those surveyed believe that a flexitarian diet has a positive impact on climate change.

4.2.7. Willingness to buy flexitarian food products

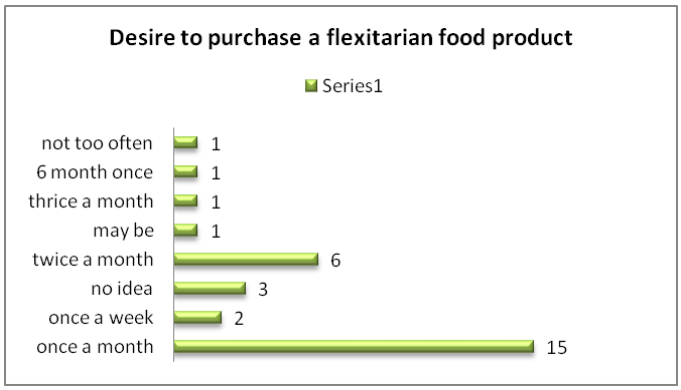

Figure 14: *The results of panels willingness to buy flexi hot dog*

Participants were also asked if they would be interested in purchasing Flexi hot dogs if they become available on the market (Figure 14). There were a variety of interesting responses, about 15 people responded that they will buy flexitarian hot dogs once a month, a few also added that they are also concerned about the cost and depends on how affordable the product is, 6 people said they are interested in buying twice a month, And about 2 people said they will buy once a week. Other people said they will buy it once in 6 months, thrice a month, maybe they will try to buy. About 3 people said they have no idea if they will try to buy or not but also added that they don't eat sausages often, or that they prefer buying only meat sausages, or that they don't prefer processed foods.

4.2.8. A summary of the findings of the market research study

The general findings of consumer research shows that people are aware of the concept of flexitarian diets and believe it is simple to follow. They are also concerned about lowering meat consumption, eating more climate-friendly foods, and eating more plant-based meals. The age group of 20-30 was more interested

in diets; this group has given some key responses about how they balance the benefits and negatives of various diets; this group picked flexitarian diets more than others. Another significant element is that this group of people represented the majority of those who participated in the survey, and the majority of them were university students, the majority of whom are also Swedes.

In general, the 41-60 age group did not have any particular dietary preferences, and the majority of them are meat-eaters. A few also shared that they try to reduce meat intake, they also do not prefer processed foods and prefer home-cooked meals, but the majority of them chose flexitarian over vegan and added that they are easy, and a few do not understand exactly about diets. There were no desirable answers to discriminate across age groups and gender for the question of whether participants are willing to buy Flexi hot dogs in future or not. Individuals thought flexitarian diet are easy to follow and beneficial for the environment, and few people identified as flexitarians, according to panelists. Another notable finding was that 57 percent of people prefer a flexitarian diet, which is a remarkable finding. This demonstrates that the majority of individual's preferred the flexitarian diet and wanted to follow it.

To summarize, the market research provides that participants understand diets are an important element of their health and for the environment. The dietary alterations that propose moving to a plant-based diet have been subjected to people's lives, whether they want to try more plant-based but still want to consume animals on occasion, in which case they pick and define the flexitarian diet as an adaptable diet. The majority of participants were interested in purchasing flexitarian sausage at least once a month if it would be introduced to the market, indicating that consumers are eager to purchase new goods that complement specific diets.

The consumer research survey has some limitations since the results cannot represent the perspective of broader research since it is conducted on a smaller scale and cannot be compared to the general audience. Other limitations of this study include the fact that it was conducted by persons residing in Uppsala; people from different regions of Sweden may have different ideas about diets and flexitarian diets in general. Additionally, the majority of participants comes from academic backgrounds and have a positive motivation towards the flexitarian diet and flexi hot dog. Consequently, it is unsuitable for the results to represent the Swedish population in general yet have an influence on this study.

4.2.9. Discussions

To understand more about the people's motivation towards becoming flexitarians. The research study has been conducted in France it aimed to identify the various stages of transition to low-meat diets, define how these diets differ in terms of food intake, and determine if attitudes and beliefs may explain these stages of transition. This representative poll of the French adult population, the variation between the 129 flexitarians (6.3%) and the 381 pro-flexitarians (18.2%) (Dagevos, 2021).

The result from that France study shows first group flexitarians has regulated their consumption of red and processed meat more significantly than the medium meat-eating pro-flexitarians. Other distinctions are that pro-flexitarians do not affirm themselves as flexitarians but are strongly contemplating lowering their meat intake especially beef and pork in the best interest of a higher intake of plant-based foods particularly vegetables and legumes, mainly for environmental sustainability reasons, whereas flexitarians are already more accustomed to eating non - meat dishes and are willing to pursue a less animal-based and more plant-based diet (Dagevos, 2021). In the consumer research survey for Flexi hot dogs, 12 percent of participants stated that they are trying to eat plant-based foods most of the time and reducing meat products (Figure 11). This group of people reflect like a pro flexitarian attitude mentioned in above study, as they do not represent themselves to be flexitarian but consistently try to be conscious enough to reduce their meat intake. Hence the result of French study is similar to the results found in this study as consumer group have showed similar motivations towards reducing meat intake also increasing their plant-based foods.

Due to many constraints, the results of this consumer study cannot accurately represent the consumer insights that should be considered when the flexitarian sausage is ready to be introduced to the market. Therefore, it is worthwhile to investigate other comparable products that have been introduced to the market for further developments in Flexitarian sausage market launch.

UK market has been experimenting the introduction of meat hybrid products in market in total 38 hybrid meat products were introduced in the UK between 2016-20; 12 of these items appear to still remain on the market today. These figures are not shocking because it is well-known that the majority of novel foods fail to find a market. Sausages were the most common hybrid meat products officially launched, with 20 varieties, followed by meatballs with 7, burgers with 6, and mince with 5. Different base meats are utilized; the most popular were beef and pork (16 and 15 products, respectively), next by chicken (5 products) and lamb (2 products). The ratio of meat to non-meat ingredients varies greatly, ranging from

25% - 50% of vegetables. there is growing consumer interest in processed meat products with plant-based ingredients (Grasso & Jaworska, 2020).

Overall, it appears that the most recent product launches have less to do with flexitarianism and are more focused on the flavour, healthfulness, and ease of access of these meat products, emphasizing ideas like the 5-a-day, the comfort of having vegetables already in minced meat, through the use of veggies as flavour enhancers. Therefore, this shows that consumers who care about their health and convenience enjoy the hybrid meat products than the people who like to reduce meat consumption and flexitarians (Grasso & Jaworska, 2020). Hence it is necessary to codevelop and codesign these kind of new foods with consumers demands for these niche products to be successful, and the new product development literature emphasizes the significance of incorporating consumer insights into the new product development process for foods (Grasso & Jaworska, 2020). Therefore, in order to successfully compete in the market, flexitarian sausage future developments should focus more on understanding consumer expectations, market segmentations including not just sensory aspects but also other elements such as labelling and marketing techniques.

4.3. Nutritional Assessment results

The nutritional composition of ingredients like Mung beans, cattle blood, and pig intestine has been calculated (Table 3). In terms of sensory analysis results, panel members preferred recipe 2, so recipe 2 for 1kg of sausage was chosen for nutrient evaluation (Table 1). **(**Complete list of ingredients composition can be found in appendix 6.2)

Table 3: *Nutrient content of Flexi hot dog- recipe "2"*

Nutrient content	**Mung bean dried 408 (g)** (Livsmedalsverket, 2022)	**Cattle blood 102 (g)** (Livsmedalsverket, 2022)	**Pork Intestine 30.6 (g)** (Jeon, Kim, Kim, Shon, & Lee, 2010)	**Total nutrient content per (kg)**	**Total nutrient Content per 100 (g)**
Energy (Kj)	5471	294	-	5765	577
Energy kcal	1306	70	-	1376	137
Carbohydrates (g)	181	0	0	181	18
Fat (g)	5.3	0.4	0	5.7	0.6

Protein (g)	98	16.4	3.7	118	12
Fibre (g)	65	0	0	65	6.5
Sugar (g)	4.8	0	0	4.8	0.5
Sum of saturated fatty acids (g)	1.6	0.1	2.4	4.1	0.4
Vitamin K (µg)	-	0	0	0	0
Iron (mg)	31	35.5	0.3	67.2	6.7
Calcium (mg)	481	7	3.21	492	49
Potassium (mg)	4284	43	76.2	4403	440
Magnesium (mg)	694	2	3.73	699	69
Sodium (mg)	0	330	14.13	344	3.44
Zinc (mg)	11	0.4	0	11	1.2
Cholesterol (mg)	0	190	54.33	244	2.45

The table 3 shows the results of nutrient content of recipe 2-flexi hot dog. The nutrient evaluation findings showed that the Flexi hot dog provides energy in kcal per 100 g of sausage about 137 Kcal and a fair amount of proteins about 12 g. Sausage also contains roughly 6.5 grams of fibre per 100 grams. Despite the fact that sausage contains animal-derived components, it has relatively low levels of saturated fatty acids amount 0.4 and total fat amounts of 0.6. Flexi hot dogs provide a good amount of vital vitamins and minerals such as, calcium about 49 mg, potassium about 150 mg, magnesium about 69 mg, iron about 6.7 mg, and zinc about 1.2 mg (Table 3).

Table 4: *Comparison of nutrient content of Flexi hot dog to Anamma vegan sausage*

Nutrient content	**Anamma vegan sausage 100 g**	**Flexi hot dog 100 g**
Energy KJ	743 KJ	577 KJ
Energy kcal	178 Kcal	137 kcal
Fat	11 g	0.6 g

saturated fat	0.9 g	0.4
Carbohydrate	4.3 g	18 g
sugars	1.7 g	0.5 g
Fibre	4.5 g	6.5 g
Protein	13 g	12 g
Vitamin K (µg)	-	0
Iron (mg)	-	6.7
Calcium (mg)	-	49
Potassium (mg)	-	440
Magnesium (mg)	-	69
Sodium (mg)	-	3.44
Zinc (mg)	-	1.2

the nutritional evaluation results of Flexi hot dogs were compared to a vegan sausage made by Anamma brand (Anamma, 2022) (Table 4). Vegan sausage has been made using ingredients like, water, soy protein (17%), rapeseed oil, onions, spices (including peppers and coriander), salt, maize starch, garlic, tomato, apple extract, pea fibre, pea starch, natural smells, smoky scent, stabilizer (methylcellulose), dye (iron oxide) are the ingredients utilized by them. The calories in the Flexi hot dog are less than those in the vegan sausage. Although the fibre value of Flexi hot dogs is higher than that of vegan sausage, Flexi sausage has a greater carbohydrate load-

Flexi hot dogs contain less protein than vegan sausage, but vegan sausage has been made with soy protein extract of about 17% which explains the higher protein content in the final product, future development of Flexi product should take this into consideration of increasing its protein value. The Flexi hot dog has a lower amount of fat and saturated fat than the vegan sausage even though it has animal derived ingredients. There is no information from anamma brand about the vitamins and minerals in their nutrient content list (Table 4). Some scope and limitations of the nutrient assessment results, it needs to concern that this nutrient evaluation is solely performed using data from web sources; thus, if the real product is subjected to chemical analysis, the findings may differ in terms of the quantity of nutrient content. As a consequence, the results produced is only an indicative analysis.

4.3.1. Considering Nordic nutrition recommendations and Flexi hot dog

According to Nordic nutrition guidelines, adults' carbohydrate consumption should range between 45% and 60% of their total energy intake, which is regarded to be a moderate intake according to NNR 2012. Total carbohydrate ranges can be utilized as complementing targets, with the intermediate number (52–53 E percent) serving as an acceptable objective. (Nordic co-operation, 2014) because the Flexi hot dog has enough carbohydrates to offer 137 kcal of energy per 100 g of Flexi sausage, it is suitable for individuals who lead a healthy lifestyle.

Dietary patterns linked with a lower risk of chronic illnesses are characterized by an accumulation of fibre-rich foods that are mostly composed of slowly digesting carbs such as wholegrain cereals, whole fruit, berries, vegetables, and pulses (127). These foods should be the primary sources of carbs in the diet. This guideline states that people should ensure that their carbs come from whole grains cereals and other indicated foods. Because Flexi hot dogs are composed of mung beans filled with high protein and carbohydrate rich grains, they are a great approach to promoting whole grain consumption. (Nordic co-operation, 2014) Although the Flexi hot dog contains animal-derived components, it does not contain a larger amount of fat of about 0.6 g. Because of the high fibre content of about 6.5 g per 100 g and protein weight of about 12 g per 100 g of Flexi sausage, This Flexi food product is a fantastic choice to be added at least once a week or once a month to live a healthy lifestyle and as well as beginners to start a flexitarian diet (Figure 4).

4.3.2. Iron content

Iron deficiency anaemia (IDA) is the most frequent micronutrient deficit worldwide and many demographic groups have increased iron requirements but inadequate iron availability or absorption to meet those needs. According to recent Nordic dietary surveys, iron consumption among adult men and women ranges from 11 to 14 mg/d on average, with women consuming much less than males. As the recommended iron intake is 15 mg/d for men and women (Nordic co-operation, 2014). As the data says Swedish adults are lacking enough Iron intake this makes it essential to ingest enough iron in their diet. Flexi hot dogs do provide iron 6.7 mg of iron per 100 g of sausage which is almost 50% of recommended intake (Figure 4). If a person consumes 200 grams of flexi hot dog, they would be able to get 13.4 mg of iron. This would be sufficient to daily

recommended intake for any individual who follows the flexitarian diet or any individual.

Iron in foods can be distinguished as haem iron and non-haem iron. Haem iron contributes to around 10% of total iron in the Nordic diet and is mostly found in meat, where it contributes to almost half of the total iron content. In general, haem iron is more effectively absorbed than non-haem iron (Nordic co-operation, 2014). Because blood is regarded to be a great biological source of iron, and blood is one of the essential ingredients in flexitarian sausage, iron from blood is efficiently absorbed by the human body. This is beneficial to everyone who consumes flexitarian sausage.

4.4. Carbon footprint results and discussions

The CF values of each raw material used in the manufacturing of sausage are computed and tallied to one kilogram of Flexi hot dog (Table 6). The upscaled version of recipe 2 has been taken to calculate the carbon footprint as it is liked better by panel members in sensory evaluation. The equation below demonstrates how the overall CF value for 1kg of Flexi hot dog was calculated (Equation1).

Equation 1

CF value for 1 kg Flexi hot dog [kg CO2e] = sum of (CF value for each ingredient [kg CO2e/kg] * quantity of each ingredient used [kg]) + CO2e from electricity use

Table 5: *The results of Carbon footprint analysis of flexi hot dog recipe 2*

Raw Material	**CF Value of ingredients from reference article [kgCO_2eq/kg]**	**Recipe 2 for 1kg sausage**	**CF contribution per ingredient [kgCO_2eq/kg]**
Mung beans	0.6	408 g	0.2
Beef blood	8	102 g	0.8
Pork intestine	3.1	31 g	0.09
Spice	1.6	31 g	0.05

Water	0	429 g	0
Rapeseed oil	2.9	20 g	0.06
Electricity	0.029/kWh	0.03	0.03
Total CF Value for 1kg Flexi hot dog [kgCO_2eq/kg]	**1.3 [kgCO_2eq/kg]**		

After careful study, all reference values for ingredients used in the making of sausage were obtained from different reference publications and websites (Table 2). Using the above-mentioned equation 1, the CF value of sausage in kilograms of CO_2eq/kg was calculated. The carbon footprint study result shows CF value of Flexi hot dog is 1.3 kg CO_2eq/kg.

Table 6: *Comparisson of CF value of flexitarian sausage to vegan sausages and Meat sausage*

Type of sausage	**Flexi hot dog**	**Ikea Vegan sausage** (Koty, 2018)	**Anamma Vegan Sausage** (Anamma, 2022)	**Meat Hot dog** (Abelmann, 2005)
CF Value [kg CO_2e/kg]	1.3	1.0	1.5	3.9

When comparing Flexi hot dog to vegan hot dog made by Ikea, which contains components such as kale, red lentils, carrots, and ginger, the CF value is 1.02 kgCO_2eq/kg (Koty, 2018) is slightly low to the value of Flexi hot dog, which is 1.3 kgCO_2eq/kg. Ikea claims that this new vegan sausage decreases environmental impact by around seven times compared to their traditional meat sausage, which is approximately 3.9 kgCO_2eq/kg (Abelmann, 2005). As a result, Flexi hot dogs have an almost similar environmental impact as vegan variants while also making efficient use of animal resources and providing animal nutrition. When comparing flexi hot dog CF value to Anamma brand vegan sausage Have a climatic impact of about 1.5 kgCO2eq/kg (Anamma, 2022). This number indicates that the Flexi hot dog has a lower CF value than the Anamma vegan sausage. Some of the limitations encountered during the carbon footprint study include the inability to get data for some items, thus they are compared to other similar products

processed in a similar manner. As a result, there may be some uncertainty in the outcome (Table 6).

Table 7: *Environmental impact when flexitarian sausage replaces barbeque sausages*

Sausage Type	**CF Value [kg CO_2eq/kg]**	**Quantity sold [Tonnes]**	**Environmental impact [Tonnes CO_2eq]**
Barbeque sausage sold	3.9 (Abelmann, 2005)	1100 (Eriksson, 2015)	4300
Flexitarian sausage	1.3 (Table 5)	1100	1400

To discuss about how much lower the environmental impact would be if meat sausages were replaced with flexitarian sausage (Table 7). It has been reported that the amount of barbecue sausages sold in six Willys supermarkets in Sweden's Uppsala-Stockholm region was approximately 1100 tonnes for the five-year period between 2010 and 2014 (Eriksson, 2015). If the same amount of consumers switched to the flexitarian sausage instead of barbeque sausage, CO2 emissions would be reduced by 2900 tonnes, equal to using 1000 m^3 of petrol from well to wheel (miljofordon, 2022).

4.5. Important suggestions for future developments:

In the future, flexitarian food product development will need to analyse more of potential new ingredients like Swedish grown legumes in order to support more locally produced products. The expected change in climatic conditions may enhance legume production, accelerating the transition from animal-based to plant-based protein. However, quinoa, lupin, and common beans, all members of the legume family, are now grown in modest quantities in certain regions of Sweden, along with fava beans and peas. (Sudarshan & Ramesh, 2022) Hence making use of these legumes will also promote more potential use of locally grown crops than going to imported food. Furthermore, due to their high protein content of 22-25 percent, legumes are considered the meat of the plant kingdom (Sudarshan & Ramesh, 2022) Hence making use of these protein rich Swedish legumes to produce flexitarian food products would be an excellent start for sustainable food transition in Sweden. According to the Swedish National Food Strategy, it is critical to expand Swedish food production and shift away from

imported foods and toward locally cultivated crops by making more plant-based goods with Swedish raw materials, it is possible to turn imported items into Swedish counterparts (Sudarshan & Ramesh, 2022; Ministry of Enterprise and Innovation-Sweden, 2017).

In order to avoid deviating from the concept of a flexitarian diet and to ensure that flexitarian food production does not stimulate meat production, this study suggests that future flexitarian food product development should use as much plant-based material as possible and a less animal derived ingredient as possible. Further the selection of animal ingredient in future development should consider using animal by-products than using red meat. Besides other possible animal by-products, such as organ meat, which is often underutilized should from animals raised on Swedish farms. The selection of animal components demonstrates that in order to generate flexitarian food products, it is not necessary to promote red meat consumption or to increase animal meat production in order to make flexitarian food products.

5. Conclusions

Some concluding points of this study, the flexitarian hot dog developed has delighted in terms of sensory elements, Recipe 2 has got higher rating of 7 and thus becomes winning version. Both the recipes overall impressions scores a good ratings. As a result, the findings are more promising since the sausages were enjoyed more by panel members, despite minor defects such as a lack of juiciness and tenderness. The nutritional composition of the flexitarian sausage showed that flexi hot dog provides sufficient nutrients corresponding to Nordic nutrition recommendations, as 100 g of Flexi hot dog has a high energy 137 kcal, high carbohydrate content of 18 g, and an iron content of 6.7 g which is 30% of recommended daily intake. When compared to other vegan sausage the protein content is less of 12 g, and high fibre content of 6.5 g, and low fat of 0.6 g while the Flexi hot dog does provide a fair share of vitamins and minerals like, calcium 49 mg, potassium 440 mg, magnesium 69 mg, sodium 3.44 mg and zinc 1.2 mg. The general findings of consumer research shows that people are aware of the concept of flexitarian diets. About 57% of them chose flexitarian over vegan and believe it is easier to follow than the strict vegetarian diets. They are also concerned about lowering meat consumption, eating more climate-friendly foods, and eating more plant-based meals. and about 15 participants stated that they would buy flexitarian sausage at least once a month. The CF value shows that the Flexi hot dog has a low environmental effect of roughly 1.3 kgCO2eq/kg hence this product has good influence on environment. This study suggest future development of flexitarian food product development should not deviate from the notion of flexitarian diet and also make use of legumes and other possible animal co-products.

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6. Appendix

6.1. Sensory evaluation using 9 point hedonic scale

Recipe 1	1 Terrible	2 Very bad	3 Bad	4 Just little bad	5 May be goodOr bad	6 Just little good	7 good	8 Very good	9 Great
Bean taste									
Meaty taste									
juiciness									
Tenderness									
Spice intensity									
Overall impression									

Recipe 2	1 Terrible	2 Very bad	3 Bad	4 Just little bad	5 May be good Or bad	6 Just little good	7 good	8 Very good	9 Great
Bean taste									
Meaty taste									
juiciness									
Tenderness									
Spice intensity									
Overall impression									

6.2. Consumer Research survey questions to panel group

1. Could you please tell me your age?
2. Could you please state your gender?
3. Where did you come from?
4. Have you got any dietary preferences?
5. What is your opinion about flexitarian?
6. When the flexi hot dog hits the market, how frequently will you buy it?
7. Which is better: vegan or flexitarian?

Thank you for participating!

6.3. Nutritional content of Ingredients

Nutrient	Mung beans dried
Weight standard (g)	100
Energy (kcal)	320
Energy (kJ)	1341
Carbohydrates calculated as residue (g)	44,5
Fat, total (g)	1,3
Protein (g)	24
Fibers (g)	16
Water (g)	10,7
Alcohol (g)	0
Ash (g)	3,5
Total sugars (g)	1,2
Monosaccharides (g)	0,4
Disaccharides (g)	0,8
Added sugar (g)	0
Free sugar (g)	0
Total saturated fatty acids (g)	0,4
Fatty acid 4:0-10:0 (g)	0
Lauric acid C12:0 (g)	0
Myristic acid C14:0 (g)	0
Palmitic acid C16:0 (g)	0,3
Stearic acid C18:0 (g)	0,1
Arachidic acid C20:0 (g)	0
Sum monounsaturated fatty acids (g)	0,2
Palmito oleic acid C16:1 (g)	0
Oleic acid C18:1 (g)	0,2
Sum of unsaturated fatty acids (g)	0,4
Linoleic acid C18:2 (g)	0,4
Linolenic acid C18:3 (g)	0
Arachidonic acid C20:4 (g)	0
EPA (C20:5) (g)	0
DPA (C22:5) (g)	0
DHA (C22:6) (g)	0
Thiamine (mg)	0,38
Riboflavin (mg)	0,2

Niacin (mg)	2,6
Niacin equivalents (NE/mg)	6,6
Vitamin B6 (mg)	0,5
Folate (µg)	625
Vitamin B12 (µg)	0
Vitamin C (mg)	0
Vitamin A (RE/µg)	4
Retinol (µg)	0
β-Carotene (µg)	48
Vitamin D (µg)	0
Vitamin E (mg)	0,3
Vitamin K (µg)	not analyzed
Phosphorus, P (mg)	340
Iodine, I (µg)	not analyzed
Iron, Fe (mg)	7,7
Calcium, Ca (mg)	118
Potassium, K (mg)	1050
Magnesium, Mg (mg)	170
Sodium, Na (mg)	6
Salt, NaCl (g)	0
Selenium, Se (µg)	2
Zinc, Zn (mg)	2,8
Cholesterol (mg)	0
Whole grain total (g)	0
Waste (shells, etc.) (%)	0

Nutrient composition	**Cattle blood 100 ml**
Weight standard (g)	100
Energy (kcal)	70
Energy (kJ)	294
Carbohydrates (g)	0
Fat (g)	0,4
Protein (g)	16,4

Fibre (g)	0
Water (g)	81,8
Monosaccharides (g)	0,1
Disaccharides (g)	0
Sucrose (g)	0
Sugar total (g)	0,1
Sum of saturated fatty acids (g)	0,1
Fatty acids 4:0-10:0 (g)	0
Fatty acid 12:0 (g)	0
Fatty acid 14:0 (g)	0
Fatty acid 16:0 (g)	0
Fatty acid 18:0 (g)	0
Fatty acid 20:0 (g)	0
Sum of monounsaturated fatty acids (g)	0
Fatty acid 16:1 (g)	0
Fatty acid 18:1 (g)	0
Sum of polyunsaturated fatty acids (g)	0,2
Fatty acids 18:2 (g)	0,1
Fatty acid 18:3 (g)	0
Fatty acid 20:4 (g)	0
EPA (Fatty acid 20:5) (g)	0
DPA (Fatty acid 22:5) (g)	0
DHA (Fatty acid 22:6) (g)	0
Thiamin (mg)	0,09
Riboflavin (mg)	0,03
Vitamin C (mg)	0
Niacin (mg)	0,8

Niacin equivalents (NE/mg)	3,81
Vitamin B-6 (mg)	0,01
Vitamin B-12 (µg)	0,6
Folate (µg)	12
Retinol (µg)	28
Retinolequivalents (RE/µg)	28
Beta-carotene (µg)	0
Vitamin D (µg)	0,1
Vitamin E (mg)	0,4
Vitamin K (µg)	not analysed
Phosphorus (mg)	23
Iron (mg)	35,5
Calcium (mg)	7
Potassium (mg)	43
Magnesium (mg)	2
Sodium (mg)	330
Salt (g)	0,8
Selenium (µg)	9
Zinc (mg)	0,4
Cholesterol (mg)	190

Nutritional composition	**Pork intestine 100gm**
Energy kj	-
Energy kcal	-
Protein g	11.74
Fat g	7.5
Cholesterol g	171.95

Calcium mg	10.18
Potassium mg	85.69
Iron mg	0.95

6.4. Pictures of Flexi sausage making

a) Mung beans, cattle blood, pork intestine

b) Closer picture of mung bean

c) Grinding mung bean with blood

d) Spices were added to the mixture

e) Closer look of the mixture

f) Adding mixture to the casing using simple kitchen funnel

g) Sausages ready for cooking

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