Consumer acceptance of meat substitutes

The roles of product, context and consumer characteristics

Hanneke Elzerman

Propositions

1. The match of different meal components is the basis for product development of meat substitutes.

   (this thesis)

2. Design of meat alternatives for luxurious and festive situations helps to promote meat reduction.

   (this thesis)

3. Political climate change rather than climate change models is needed to slow down global warming.

4. The freedom to follow one's own biological clock enhances sustainable employability.

5. Shrinkflation of food products, package downsizing due to inflation, is good for public health.

6. Dropping off children at school by car puts children's health at risk.

Propositions belonging to the thesis, entitled

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CONTENTS

CHAPTER   1

General Introduction

1.1   The need for reduction of meat consumption

Over the last decades, it has become clear that worldwide food consumption and food production systems have a substantial impact on the environment. The livestock sector is the most resource-intensive and polluting sector of the food industry since it has a big impact on greenhouse-gas emissions and the use of fresh water and land (Godfray, 2018; Hallström, Carlsson-Kanyama, & Börjesson, 2015; Vinnari & Tapio, 2012). More specifically, the production of beef is the most burdensome practice in the livestock sector, as it uses about 70% of the world's agricultural land (van Zanten, Herrero, van Hall, Röös, Muller, Garnet, Gerber, Schader, and de Boer, 2018). The total livestock sector is estimated to represent 14.5 to 18% of human-introduced greenhouse gas emissions, which are related to climate change (Gerber et al., 2013; Herrero et al, 2011). Targets have been set in the Paris agreement to reduce greenhouse gas emissions from livestock to mitigate the global temperature rise (UNFCCC, 2020). Although meat consumption is stabilizing or even starting to decline in some developed countries, it is increasing in many parts of the world such as Asia, South America and Africa (Macdiarmid, Douglas, & Campbell, 2016; OECD/FAO, 2021). At the same time, it is estimated that the global population could grow from 7.7 billion in 2019 to around 9.7 billion in 2050 (United Nations, 2019), and therefore it is expected that global meat production will keep on growing for the next decades as well (Aiking, 2011; OECD-FAO, 2021). The fast-growing population combined with rising incomes in developing countries have led to an increase of 57% in the global demand for meat and is expected to keep on growing at an annual growth rate of around 7% during the forecast period 2020–2025 (Kim et al., 2020; Boukid, 2021).

Due to the environmental pressure and with the still-growing meat production and consumption in mind, a shift in our dietary behavior from an animal-based diet to a more plant-based diet is a need to be environmentally more sustainable (Aiking, 2020; Tijhuis, Ezendam, Westenbrink, van Rossum, & Temme, 2011; Smil, 2002). Technological advances and reducing food production waste alone will be insufficient to lower the emission of greenhouse gasses to meet the Paris agreement targets for the reduction of greenhouse gas emissions, so dietary habits must change as well (Macdiarmid *et al*, 2016). The EAT Lancet Commission on Food, Planet, Health Efforts recommended in their recent report a drastic reduction of over 50% of red meat consumption in Western countries over the coming decades. This recommendation was made to make our food system more sustainable, as well as healthier (Willett et al., 2019). The consumption of red and processed meat is related to several diseases, such as cancer and type 2 diabetes (Willett *et al*, 2019). The reduction of meat production could also positively influence other issues related to livestock husbandry, such as animal welfare and the prevention of infectious diseases, such as zoonoses (Espinosa, Tago & Treich, 2020; Temple & Mantega, 2020). An alternative for meat could be plant-based meat substitutes since meat substitutes can have a lower environmental impact than meat (Smetana, Mathys, Knoch, & Volker Heinz, 2015). Their ecological footprint, based on the carbon footprint (kg CO_2 per kg product) and land use (Nijdam, Rood, & Westhoek, 2012), is

lower. Hence, the replacement of meat with meat substitutes could be a fruitful way of reducing the environmental burden the meat chain is causing today.

1.2   The role of meat in the Dutch diet

To understand the perception of meat substitutes by consumers, some insight into the role of meat in the Dutch eating culture and diet is necessary. For many Dutch consumers, meat is still the center of the main daily meal. A dish with 'potatoes, vegetables and meat' has long been the standard in the Netherlands and is still eaten regularly in many households. This trinity became mainstream among the middle class at the beginning of the 19th century while the poor could not afford meat (de Vré, 2012). Meat was eaten for its nutritional value while vegetables were not seen as real food and it was believed that eating meat would bring strength, civilization and progress (Verdonk, 2009). After WWII, eating meat became common in other classes as well, and meat consumption increased. Besides, the Dutch eating habits started to be influenced by Indonesian, Chinese and Italian immigrants and later by other cultures, and consumers started to use meat in different types of meals, such as pasta and rice dishes (Verriet, 2015). Traditions and routines developed in which meat played a role, such as Christmas dinners and other celebrations and barbecues in summer (de Krom *et al*, 2020). In the 1950s, meat consumption was promoted by the Netherlands Nutrition Center, because it was believed to be required for a sufficient protein intake, however, it was expensive for many consumers and seen as a luxury product. Since the beginning of the 1980s, a mostly plant-based diet was advised (Voedingscentrum, 2022), but around 28% of the protein intake still comes from meat, and 61% is animal-derived (RIVM, 2020).

While meat consumption more than doubled from roughly 17 kg per capita per year in 1950 to around 39 kg today, it has been quite stable in the last two decades (Voedingscentrum, 2022). However, consumer data suggest some changes in eating behavior: while during the latest Dutch National Food consumption survey, between 2012 and 2016, most consumers still ate meat six days a week, a study from 2020 showed that only 30% of the respondents ate meat on 5 or 6 days a week, while 45% indicated to eat meat only on four days a week maximum (Kloosterman, Akkermans, Reep, Wingen, Molnár-In 't Veld, and van Beuningen, 2021; RIVM, 2022). The Dutch meat consumption is comparable to other European countries and lower than the meat consumption in North America and Oceania, but a lot higher than the max. 26 kg/year that the Netherlands Nutrition Center recommends (Dagevos 2020; OECD/FAO, 2021; Statistica, 2021; Voedingscentrum, 2017).

Meat is deeply embedded in the Dutch eating culture and this could explain part of the high and steady consumption of meat (Jobse van Putten, 1996; Verain, Dagevos & Jaspers, 2022). Meat is eaten mainly as part of dinner (71%) and lunch (18%) and much less with breakfast or as a snack (RIVM, 2020). Positive attitudes toward meat still predominate among non-vegetarian consumers, especially with respect to the sensory properties and nutritional value

(Hoek et al, 2011; Schösler, de Boer, Boersema, 2012; Apostolidis & Mc Leay, 2016; Potts, 2016).

However, there have always been groups of people that did not consume meat. At the beginning of the 20th century, there were quite a few consumers who would refrain from eating (certain types of) meat, mostly for religious reasons, but after the food scarcity during WWII, eating meat was seen as one of the first signs of welfare and prosperity (Kruyff, 2017). It took until the 1970ies until the next wave of vegetarianism when people with an alternative lifestyle rejected meat because of animal welfare and environmental issues (Verdonk, 2009). The percentage of vegetarians in the Netherlands today is estimated between 3 and 6% (de Waart, 2020). More consumers developed an interest in reducing meat from around the year 2000 onwards (Hoek, Luning, Stafleu & de Graaf, 2004). Their reasons were mainly related to food scares (such as the dioxin crisis in 1999 and avian flu), health and environmental issues (Grünert, 2006). This group of consumers who are conscious of the need for meat reduction are often called 'flexitarians', 'meat reducers' or 'part-time vegetarians'(Hoek et al, 2004; Apostolidis & McLeay, 2016, Verain & Jaspers, 2020), and this group of self-appointed flexitarians grew from 14% in 2011 to 43% in 2019. Where twenty years ago flexitarians only consumed meat for one day a week maximum, the term flexitarian has now been embraced by many consumers who are willing to reduce their meat consumption. Verain & Jaspers (2020) concluded that the term flexitarian is subject to inflation since consumers who define themselves as flexitarians today often eat meat several days a week. This underlines, however, that a large group of consumers is interested in the reduction of meat consumption and find it socially desirable to eat less meat, but that it is difficult to adopt such a lifestyle. Eating habits, the enjoyment of meat and health concerns may hinder such a lifestyle change (Szejda, Urbanovich & Wilks, 2020).

1.3   The rise of meat substitutes

Meat alternatives have been around for a long time in the Netherlands, although not always well-known by the larger public. As early as the beginning of the 20th century, different types of meat alternatives were prepared at home by several religious groups who did not eat certain types of meat, and often, these products were attempts to resemble meat in their appearance and taste (Kruyff, 2017). Another product that became well-known as a meat alternative was tofu, which is made from soybean curd and originates from Asia. Tofu has been known by vegetarians and health food consumers in Western Europe and the USA since the 1960s (Shurtleff and Aoyagi, 2004), and has been part of the supermarket assortment for long. Textured vegetable protein (TVP) was developed in the 1970s from spun soy protein, aimed to mimic meat, but failed with the larger public (Richardson, 1982). Meat substitutes, products that were produced to substitute meat in the meal, like vegetarian burgers, sausages and mince, were found in organic food stores since the late 1980ies and some years later in supermarkets as well (de Waart, 2021). The meat substitute market was a niche market for a

long time. However, in the mid 1990ies, after the introduction of Quorn™ which is a product based on mycoproteins that resembles meat texture, the meat substitute assortment expanded with more meat-like products. Different ingredients (protein sources) and techniques were used to develop meat substitutes that mimic the sensory properties of meat, as this seems to be important for non-vegetarian consumers (Hoek, Luning, Weijzen, Engels, Kok and de Graaf, 2011; Apostolidis & McLeay, 2016; Dekkers, Boom & van der Goot, 2018).

The meat substitute market has grown steadily over the last decades. The growth rate was around 4% every year, but between 2017 and 2019 a growth of 51% was established. However, only just above 5 euros per capita per year is spent on meat substitutes by Dutch consumers (Meesterburrie, 2019, Menkveld, 2019; IRI Nederland, 2019). Consumers of meat substitutes are predominantly women, higher educated, and more often from urbanized residential areas when compared to consumers who eat (more) meat (Hoek et al, 2004). Despite the growing market, meat substitute consumption is still low. Reasons for this could be food neophobia, lower perceived sensory quality, health perception and relatively high price (Hoek *et al*, 2011; Apostolidis, 2016). Furthermore, ethics and sustainability, important drivers for vegetarians, do not seem to be important for the majority of meat-eaters (Hoek et al, 2004). The different consumer preferences, as well as the sustainability gain compared to meat, are factors that should be taken into account for new product development and marketing of meat substitutes (van der Weele *et al*, 2019).

1.4   Food acceptance and the role of context and appropriateness

A transition from mostly meat-centered meals toward a more plant-based diet could be established by eating meat substitutes instead of meat. This transition has already started, with some consumers being more open to meat alternatives resulting in a growing meat substitute market. However, since meat consumption in the Netherlands is not decreasing, it seems that at least some of the prerequisites for this transition have not yet been met. Therefore, it is of vital importance to know which factors play a role in the acceptance of and choice of meat and meat substitutes.

Many researchers tried to pinpoint the factors that contribute to food acceptance and choice. When looking at different theories and conceptual models mostly product- and person-related factors take a central role and are widely studied as reviewed by Onwezen et al, 2021). Product-related factors include the intrinsic product properties, such as the physical and chemical properties and the nutritional content of the food., which are perceived as the sensory properties of the food (appearance, smell, taste and texture) and the physiological effects (e.g. hunger and satiety). Other properties that are important for the perception of food products are the extrinsic product properties, cues that come with the product, but are not part of it, such as brand name, product information, claims, labels, packaging and price (Symmank, 2019).

For a long time, technological developments dictated what products entered the market. This situation can be called 'technology push'. When the markets became more saturated, there was more competition between companies and the consumers' needs and wishes became more important. The situation in which the consumers' preferences are used as a starting point for new product development can be called 'market pull', or consumer-led product development. In this type of approach, opportunity identification by doing market and/or consumer research is one of the first steps in product development (van Kleef & van Trijp, 2007). In this process, qualitative and quantitative consumer studies give insight into consumers' experiences, expectations, perceptions and preferences regarding a certain product or product category. Additionally, consumer researchers try to characterize consumers based on their personality traits, demographics and (food-related) behavior. Examples of this are food neophobia, variety-seeking behavior, gender, age, and consumption frequency of particular products. Other factors that explain some of the variety in consumer preferences between products can be addressed to an interaction between the 'person' and 'product', such as product complexity, boredom, and aversion (Köster & Mojet, 2007).

Many models try to explain food acceptance and choice, some from a product development point of view (e.g. Shepherd, 1989; Furst, Connors, Bisogni, Sobal and Winter Falk, 1996), or more food behavior and diet-oriented (e.g. Contento, 2008). Others have a more holistic view on food choice and plead for an interdisciplinary approach of different fields like food science, nutrition, psychology, sociology and physiology working together (Köster, 2009). Besides the factors 'person' and 'product', another factor that is mentioned in all these models is 'environment' or 'context'. Context or environment can be defined as everything around an eating event, so where, when, how, with whom and with what you eat a certain food (Meiselman, 2008). However, until recently, only very little research had been done on the role of context in food acceptance (Schutz, 1988; Cardello & Schutz, 1996; and Meiselman, Johnson, Reeve & Crouch, 2000). The item-by-use appropriateness questionnaire by Schutz (1988) elicited how well certain products fitted in different usage situations. Other studies compared the amount that was consumed in different situations, or acceptance ratings for food products that were tasted in a 'sterile' Central Location Test compared to more 'naturalistic' settings (Meiselman, 2019). Studying products in their natural environment, such as eating situation and meal context, is much more time-consuming and complex than the evaluation of simple food items in a laboratory setting. These challenges, as well as having less control over external factors could explain why the role of context has been underexposed in consumer acceptance research (Cardello & Meiselman, 2018). In the last two decades, several studies highlighted the importance of context on food choice and acceptance, as reviewed by Jaeger and Porcherot (2017), who encouraged considering the ecological validity (i.e. whether the results of a study can be generalized to real-life settings) before starting consumer research, depending on the purpose of the study. The more recent consumer studies varied from home-use-tests to virtual reality to create immersive settings.

Most of the work on the context in the area of consumer research was done on the situational context. However, also meal context, the other items in a meal or dish, can influence consumer acceptance as well. It has been mostly the field of cuisine and culinary experts like vinologists and chefs to search for a good match between products and flavors, however, some scientific research has been done on 'flavor pairing' and 'congruency of flavors' (Lahne, 2019). Next to this sensory and hedonic role of meal context, there is also a more normative aspect that seems to be largely culturally defined. It is learned in early childhood what product combinations are normal (Higgs & Thomas, 2015).

For really new products, like meat substitutes, contextual factors may play a different role than for common products. While most common/conventional products play a fixed part in the meal and the diet, this is not the case for new products. Meat substitutes often look similar to meat products and the name and information on the package usually refer to the meat products they replace. This will steer the consumer's expectations toward the properties of meat products. On the other hand, other information will underline that the meat substitute is 'plant-based, 'vegan', or inform the consumer on the ingredients, and this will raise other expectations.

Meat takes up a prominent role in the diet of Western consumers. Therefore, we expect that besides affective behavior, such as liking and preference, also normative behavior, such as appropriateness plays a role in the acceptance of meat substitutes. When a consumer eats a meat substitute, expectations will be formed based on the visual cues (e.g. appearance of the product, information on the package). These expectations, together with the sensory properties of the product will determine whether the consumer considers the meat substitute to be appropriate in a certain context. The appropriateness influences consumer liking and, ultimately, acceptance of meat substitutes.

1.5   Aim and scope of this thesis

The importance of a transition from meat consumption to a more plant-based diet was recognized increasingly over the past years by researchers, policymakers, and food companies. The focus of product developers has been mainly on the improvement of product properties, whereas marketers aim to touch the right nerve by communicating the concept of meat substitutes to consumers.

The need for such a transition was the central problem statement of the multidisciplinary research program PROFETAS (Protein Foods Environment Technology and Society) that took place in the first years of the millennium (Aiking *et al.*, 2006). The first studies described in this thesis were conducted as part of this study program, in which the substitution of meat for 'novel protein foods' was studied from different perspectives. The term 'Novel Protein Foods' was used for new plant-based products that were to be developed to replace meat in the diet. Of the two consumer-related research projects in PROFETAS, the project described

here focused mainly on product properties and contextual factors and the other project had an emphasis on consumers and the process of substitution (Hoek, 2010).

In this thesis, the term 'Novel Protein Foods' is not used; '*meat substitutes*' is used instead, which are products that have been developed to substitute meat in a dish. Meat alternatives like fish, cheese, eggs, pulses, nuts etc. are not considered meat substitutes. Terms that are often found in literature as synonyms for meat substitutes are: meat alternatives, meat analogs, meat replacements, mock meat, and novel protein foods. *Appropriateness* can be defined as 'how well a product fits in a context, where *context* can be a usage situation or a meal.

The studies described in this thesis were all performed in the Netherlands. The type of meals that are consumed and the acceptance of food are culture-dependent, thus varying between countries. Therefore, we focused on the Netherlands. The goal of this research is to investigate which factors play a role in achieving the societal goal to reduce meat consumption. We therefore first focused only on meat-eaters, but in the study described in Chapters 5 and 6 also vegetarian and vegan respondents were included in the research. This was to study the difference in perceived appropriateness of meat substitutes between these groups of consumers.

Furthermore, only meat substitutes used in the hot meal were part of our research. Most of the meat consumption takes place during the hot meal (RIVM, 2020). Therefore, sandwich toppings and snacks were not part of our focus.

This thesis aimed to investigate the roles of the product, the context and consumer characteristics in the acceptance of meat substitutes.

The research questions addressed in this thesis are:

- What factors play a role in the acceptance of meat substitutes?
- How does meal context influence the acceptance of meat substitutes?
- Do meat and meat substitutes differ in situational appropriateness?
- What (sensory) properties are preferred for meat substitutes?
- What are the underlying motives for the (in)appropriateness of meat substitutes in different usage situations?

To answer the research questions, several studies were conducted as described in the following chapters:

Chapter 2 describes exploratory focus group discussions with consumers on their experiences with meat substitutes, their sensory expectations and the appropriateness of the use of meat substitutes in meals.

Chapter 3 investigates further consumers' sensory expectations, use-intention and the appropriateness of meat substitutes in meals by the use of a web-based survey with

descriptions and photographs of meat substitutes and dishes. Some consumer characteristics were taken into account (e.g. age, meat substitute consumption).

Chapter 4 focuses on consumer acceptance of meat substitutes both when tasted individually (so only the meat substitute) as well as in different dishes. This was studied in a Central Location Test.

Chapter 5 illustrates the situational appropriateness of meat substitutes as perceived by both vegetarian and non-vegetarian consumers. This web-based survey also inquired about consumer and consumption characteristics, such as age, meat consumption, meat substitute consumption and Food Neophobia.

Chapter 6 zooms into the situational appropriateness of meat substitutes through in-depth interviews with users of meat substitutes. Consumers expressed how appropriate several meat substitutes were in different usage situations and their motivations behind this.

Chapter 7 is the General Discussion, where the findings of the different studies are summarized and discussed and implications for the development and promotion of new meat substitutes are proposed. Furthermore, the limitations of the studies and suggestions for further research are described.

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CHAPTER 2

Exploring meat substitutes:

Consumer experiences and contextual factors

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Abstract

Meat substitutes can be environmentally more sustainable alternatives to meat. However, the image of these products in the Netherlands is still low. Focus group discussions were conducted to explore consumers' experiences and sensory expectations of meat substitutes and the appropriateness of the use of meat substitutes in meals. In total, 45 consumers took part in seven focus group discussions. These discussions consisted of three steps, starting with a general discussion on meat substitutes, followed by a discussion on the appropriateness of the use of meat substitutes as ingredients (minced, in pieces or slices) by using photographs of six different dishes (soup, pasta, rice, wrap, meal salad, and pizza). The discussions were concluded with a taste session with two dishes with meat substitutes. Consumers in our study regarded health aspects and easy preparation as positive aspects of meat substitutes. Lack of information on the package, and high price were reported as negative. Sensory aspects such as neutral taste or tastiness, crispiness, chicken-like texture, or granular texture were seen as positive attributes. Negative sensory aspects that were mentioned were uniform taste, compactness, dryness and softness. Most consumers found the use of meat substitutes appropriate in the dishes we presented. Our findings can, together with quantitative consumer and sensory research, be a start towards consumer-oriented product development of environmentally more sustainable meat substitutes. The central role of meal context and appropriateness is an aspect that has not yet received much attention in food science.

2.1   Introduction

Meat is an important component of the Western diet and its nutritional and hedonic aspects are highly valued (Troy and Kerry, 2010; de Bakker and Dagevos, 2010). In the rest of the world, meat consumption has also become more common. As a result of this, the consumption of animal products (including milk and eggs) in Asia increased 2.7 times from 1956 (28.7 kg/person/year) to 2006 (77.205 kg/person/year)(Nam, et al, 2010). The global per capita meat production has increased by over 60% between 1960 and 2000, and the environmental burden of meat production has increased accordingly (Tilman *et al*, 2002). A shift towards production and consumption of meat substitutes could be environmentally more sustainable (Aiking, et al, 2006; Helms, 2006; Apaiah, 2006). Meat substitutes (also called „novel protein foods") are products, generally based on plant proteins, which are developed to replace meat in the diet. Meat substitutes are produced in the form of vegetarian burgers, pieces, mince, sandwich filling, etc. Fish, cheese and nuts, often used to replace meat in a meal, are not considered as meat substitutes.

The oldest food that can be classified as a meat substitute is tofu, a soy product that has been produced in China for about 2000 years. In Western Europe and the United States, tofu has been known by vegetarians and health food consumers since the 1960s (Shurtleff and Aoyagi, 2004). At the same time, meat analogues, based on textured soy protein and aimed at the vegetarian market were introduced, followed by a product named 'TVP' (textured vegetable protein) (Johnson, et al, 1992; de Kloe, et al, 1969). Soy protein was spun into fibers to form products that were aimed to mimic meat. Several attempts, including large marketing campaigns, to make these products known by a larger public have failed. Most consumers did not accept this 'imitation meat' or 'knitted steaks' with its poor sensory properties (Richardson, 1982; Wikipedia Textured Vegetable Protein, n.d.). The reasons for this failure have never been well researched. It seemed too ambitious to develop substitutes for beef steaks, cutlets, and other large chops of meat. These early meat substitutes appeared to be very uniform in texture, and were high in springiness and dryness. Moreover, the original soy flavor and bitter flavors of soy proteins were considered off-flavors and the flavor binding capacities of soy products were a problem as well. It was suggested that it was mainly the texture of meat substitutes that did not meet sensory expectations of consumers (Richardson, 1982; Sijtsma, *et al*, 1995; de Bruin, 1995). A breakthrough in the meat substitute field came when products that were based on fungi were introduced. These Quorn® products were developed in the early 1980s and became increasingly popular with the larger public in the UK, and later also in the rest of Europe and the USA (Quorn, 2011; Wikipedia Quorn, n.d). Reasons for this may be that the texture of Quorn® closely mimics the texture of chicken and that the product was marketed as a mainstream product instead of aiming for the vegetarian niche market (McIlveen *et al*, 1999).

Many new products of different origin and with different applications appeared over recent years. Techniques like extrusion have been improved and made it possible to make meat substitutes that have a texture and moisture content that resemble meat more than the previous TVP products (Pehanich, 2004). The assortment expanded later with products based

on peas, wheat, and milk proteins, with some of the dairy based meat substitutes having fibers that resemble chicken-meat (Newmark, 1980; Davies and Lightowler, 1998; van Roots, 2005). An overview on the history and development of meat substitutes has been described by Sadler (2004).

Over 150 different meat substitutes in Dutch supermarkets and health food stores were found during our market exploration. Roughly 46% of the meat substitutes were „separate meal components" (burgers, steaks, schnitzels, sausages), 31% were products that can be used as ingredients in a dish (pieces, mince), 12% were sandwich toppings, and 11% snacks. However, the distinction between separate meal components, ingredients and snacks was not very clear, because some products have various applications. The Dutch market of meat substitutes has expanded by 76% between 1997 and 2001 (Aurelia, 2002), and has grown steadily ever since. In 2007, 36% of the Dutch households had tried meat substitutes at least once (Zwijnenburg, 2009).

Only a few studies have been published on the acceptance of meat substitutes. One of the older studies suggested that meat substitutes have an overall negative public image and that the acceptance of meat substitutes depends on different interrelated factors, including image, price, convenience, nutritional and sensory factors (Richardson, 1982). Age and (un)familiarity with meat substitutes were also suggested to play a role in the acceptance of tofu products. In a consumer study in which students and residents from an elderly home were served a tofu casserole, this dish was liked more by the students than by the elderly (Bartlett *et al*, 1998).

In many dishes, meat is the most important component of the meal. A feasible option for meat substitutes to be successful seems to be in a dish where the meat substitutes replace smaller and less pronounced pieces of meat (Aiking *et al*, 2006). Minced meat and chicken breast fillet are both popular meat products in the Netherlands (Productschappen Vee, Vlees en Eieren, 2010). Therefore, this study focused on the replacement of smaller meat components of a dish, such as pieces of chicken, slices of salami, or minced beef. The consequence of the choice for meat substitute ingredients is that other components of the meal have great influence on how the taste and texture of meat substitutes is perceived and therefore on the acceptance of meat substitutes. It is easy to imagine that for example in a spaghetti dish, meat substitute ingredients will be perceived differently than in a soup. The appropriateness of the use of meat substitutes in different dishes will be of influence on the acceptance of the meat substitute. Meal context plays a role in acceptance of foods. Meals provide contexts that can increase a food's appeal relative to items considered alone (Rozin & Tuorila, 1993). The meal can be seen as a way to add complexity and variety in the sensory combinations that we eat (Lawless, 2000). Therefore, we hypothesized that appropriateness in a meal context plays a role in the acceptance of meat substitutes. Although the appropriateness of the use of a food in different situations has been subject of several studies (Cardello, 1996; Moskowitz, 2002), the appropriateness of a food in different meals had not been studied before.

We performed focus group discussions to get a better understanding of consumers' beliefs, experiences and expectations concerning meat substitutes. We also studied whether the appropriateness of the use of meat substitutes in a dish is of importance to consumers. A focus group discussion is a qualitative technique in which a moderator focuses the attention of a small group of consumers on a predetermined set of topics in order to discuss views and opinions. It is conducted with approximately six to 12 people. Participants of the focus group discussions interact with each other; one comment from a participant can trigger comments by others (Krueger, 1994; van Kleef, 2006). Qualitative research such as focus group discussions is needed to listen to „the voice of the consumer". This type of research can be used to gather key consumer insights and direction for the new product development process (Schmidt, 2009).

To enable participants to express specific wanted and unwanted sensory characteristics and information on appropriateness, we gradually provided participants with more information. The discussions started with a general part, followed by a part in which photographs with dishes containing meat substitutes were used. According to Hutchings (2003), the sight of food can induce both positive and negative expectations of flavors and textures.

The discussions were concluded with a small sensory session in which the participants tasted two dishes with different meat substitutes. Previous research has shown that different types of information can trigger different reactions from consumers (Vriens et al, 1998). We expected that visual information and a sensory test would reveal more (specific) information from consumers than a normal focus group discussion.

2.2   Materials and methods

Panel

Seven focus group discussions with four to 8 participants per group were conducted. Some participants were part of a consumer panel of a food company, and others were recruited via an e-mail sent to employees and students of Wageningen University and Research Center. The participants were of different social classes and educational levels, and from different parts of the Netherlands. The 45 participants were all Dutch, non-vegetarian consumers between 20 and 60 years old (average age 40 years), who had some experience with meat substitutes. 11 participants were male and 34 were female. The frequency of consumption of meat and meat substitutes is shown in table 2.1.

Method

The focus groups followed general outlines that were described by Krueger (1994). However, we modified this method to the following three parts:

1. <u>General focus group discussion</u>: The participants discussed their experiences with meat substitutes. Questions that were answered during this part were: What meat substitutes do you eat? Why do you eat meat substitutes or what is the reason for not eating them anymore?

What is your opinion about meat substitutes? In what type of dish do you eat meat substitutes? What aspects of meat substitutes should be improved?

2. <u>Meal context and appropriateness</u>: the appropriateness of the use of meat substitute ingredients in dishes was discussed after the participants were shown several photographs of six different dishes (soup, meal salad, pizza, rice, pasta, and wrap). The question that was asked was: do you find the use of meat substitutes appropriate in the dish on the photograph?

3. <u>Sensory session</u>: the participants were given two pasta dishes with a tomato-based pasta sauce to taste. These two dishes were identical, except for the meat substitute that was used in the sauce. Both products were substitutes of minced meat; one was based on tofu and the other was a Quorn® product. The participants were not given any information about these dishes. They were asked whether or not they liked the dishes, which meal they preferred and why.
The last parts of the focus group were carried out to find out additional sensory attributes of meat substitutes that are important for consumers, but that did not come up during part 1 of the discussion.

Data analysis

The focus group discussions were recorded and after the recordings were transcribed, the data were organized per question and major themes were identified.

Table 2.1 Consumption of meat and meat substitutes of the 46 participants in the focus group discussions

Meat consumption		Meat substitute consumption	
≤ 1 time/week	17%	≤ 1 time/month	17%
2-4 times/week	53%	>1 time/ month, but < 1 time/week	26%
≥ 5 times/week	30%	≥ 1 time/week	56%

2.3 Results and discussion

This chapter reports a qualitative consumer study on the experiences, expectations, beliefs and attitudes regarding meat substitutes.

The consumer focus group discussions in this study were extended to three parts in order to find experiences, expectations, and (sensory) attributes of consumers towards meat substitutes that are important to consumers.

Part 1: General focus group discussion- The focus group discussions all started with the question: 'What meat substitutes do you eat or have you tried before?' All consumers together had experience with the whole range of meat substitutes available in the Netherlands (vegetarian burgers/ schnitzels, sandwich products, snacks, and meat substitute ingredients that can be used in dishes). The types of dishes in which the consumers used meat substitutes were mainly rice dishes, spaghetti dishes, or on a sandwich. However, many consumers reported that they replaced meat in a typical Dutch 'potatoes, vegetables, and meat' meal with a vegetarian burger or vegetarian schnitzel.

Many different reasons were mentioned why meat substitutes were eaten or were not eaten (anymore) (Table 2.2).

Table 2.2   Reasons for eating meat substitutes as reported by consumers during the focus group discussions

Variation in the diet
Curiosity
Vegetarian house member
Interest in vegetarian/ macrobiotic lifestyle
Animal welfare
Animal diseases/ no trust in meat
Healthier than meat
From Indonesian kitchen
To teach children alternatives to meat
As part of a weight reduction program

Some consumers were interested in these relatively new products, whereas others needed a good reason to try meat substitutes, e.g. a vegetarian housemate or guest, a diet, or a meat-related food scam. As one participant reported:

'After several food scams, like the mad cow disease, I decided to try meat substitutes. I now eat them every week.'

This part of the discussion generated many desirable and undesirable product attributes (Table 2.3). Negative aspects that were mentioned were: lack of information on the package and high price, whereas 'ease of preparation' was reported as positive. Health aspects were mentioned both as negative and positive. Some consumers expressed that they thought it was good to eat meat substitutes because these products contain less (saturated) fat than meat, but other consumers were afraid that skipping meat for one day would give them or their children deficiencies. As one participant reported:

'I cook meat for my children every day to make sure they get enough protein and iron.'

Health aspects as a reason for either eating meat or for reducing meat consumption were also found in in-depth interviews among meat eaters by de Bakker and Dagevos (2010). Participants who often cooked a meal without meat remarked that they did not see the added value of a meat substitute to their meal. They did not see the need for the replacement of something unnecessary for their meals.

Some consumers found it important that meat substitutes should have an identity of their own, but others said they would rather buy meat substitutes that resemble meat because they would find it easier to prepare a dish with it. More insight into consumer groups will be necessary to find out if there are different consumer groups that prefer either a product that resembles meat or a product with a completely new image. One of the participants explained:

'I don't like the name 'meat substitutes', because it sounds fake and I think these products should have an identity of their own.'

The negative image of meat substitutes has also been found in several studies on tofu and soy. The name tofu can negatively influence the acceptance and taste of the dish or product (Bartlett, 1998). Several studies on the presence or absence of a labeled ingredient (soy beans) in a nutrition bar showed that the soy label generated negative ratings for flavor, aftertaste and attitude, and favorable ratings for nutritiousness. This was regardless of whether the product actually contained soy beans (Wansink and Se-Bum, 2002; Wansink, 2003).

Table 2.3 <u>General</u> positive and negative attributes of meat substitutes that were mentioned by the participants during the first part of the focus groups

Positive aspects	Negative aspects
Image/ information	
Something different	No identity of their own
	No information (origin of ingredients)
	No recipes (difficult to prepare)
	Not necessary
	'Meat substitute' is a bad name
	Concerns about genetic modification
Preparation	
Easy to prepare	Unfamiliar with preparation
	Products behave sticky or jumpy in pan
Fast to prepare	Ingredients too small
Prepare the same way as meat	Takes more time to make a tasty meal
Health	
High protein-content	Nutritional value not clear
No animal fat	Children need meat (proteins, vitamins, minerals)
	Flavoring substances (not natural)
	Not easily digestible
	Expensive

During the discussions, it became clear that the discussion on whether or not one should eat meat elicited a lot of emotions in some of the participants. Meat takes in a central role in the Dutch diet, and it seems that some consumers –subconsciously- see a portion of meat with their dinner as a reward or something that they are entitled to have. A quote from one of our participants:

'We once had meat substitutes for dinner and my husband said: 'Is that what I have been hard at work for all day?'

The participants also mentioned sensory aspects during the general part of the focus group discussions. Sensory aspects such as neutral taste, tastiness, crispiness, chicken-like or granular texture were seen as positive attributes of meat substitutes. Negative sensory aspects that were mentioned were a uniform taste, soy flavor, compactness, dryness, and softness (Table 2.4). Important positive attributes of meat are flavor, juiciness, tenderness, and succulence (Troy & Kerry, 2010). What sensory properties of meat substitutes are necessary to let consumers choose meat substitutes over meat? According to this study, some consumers prefer meat-like properties and others would like taste and texture that do not resemble meat, but the properties depend on the dish in which the meat substitute ingredients are used. In two studies based on surveys (Hoek *et al*, 2004; Hoek, 2006), it was

concluded that meat-like sensory properties of meat substitutes seem to be a prerequisite for consumers to replace the meat in their meal by meat substitutes.

We expect that the success of meat substitutes and a shift toward a more sustainable, plant-based diet depends not only on the product properties of meat substitutes but also on the ease of adoption of different cuisines and new eating habits of future consumers. Once consumers are used to eating dishes in which meat does not play a prominent role or meals from a cuisine that has many vegetarian dishes (e.g. Indian), meat substitutes will be seen as products with an identity of their own, and not anymore as 'substitutes'.

<u>Part 2: Meal context and appropriateness</u> - The second part dealt with the appropriateness of the use of meat substitutes in different dishes. Photographs of six different dishes were passed around during the focus group and participants gave their opinions about the appropriateness of the use of meat substitutes in the dishes. In general, consumers were positive about the use of meat substitutes in these dishes. All participants reported the use of meat substitutes to be appropriate in a rice meal, a pasta meal with sauce, or as a filling in a wrap. However, many consumers rejected the use of meat substitutes as a topping on pizza, since they had special preferences for pizza toppings (fish, salami, etc.):

'Pizza is a treat to me, I like it with salami. I would not eat it with meat substitutes.'

Also, the use of meat substitutes in a meal salad seemed strange to some consumers, because this meal is eaten cold and consumers thought the meat substitutes would taste 'rubbery' when eaten cold. For soup, the negative responses were that the participants expected these ingredients to be soft and tasteless, and that soup balls should be tasty and firm and croutons should be crispy. A comment that was often made however was that consumers were not sure what meat substitutes could contribute to their meals.

Table 2.4   Positive and negative <u>sensory</u> attributes of meat substitutes that were mentioned by participants during part 1 and part 3 of the focus group discussions.

	Positive aspects	**Negative aspects**
Part 1		
Appearance	Looks like meat	Bad appearance
		Looks like meat (color, texture)
Smell		Fungi (when unprepared)
Taste	Neutral (ingredients)	Tastes bad
	Tasty	Tastes like meat
		Bland/flat
		Spicy
		Chemical after taste
		Uniform
		Taste becomes boring after repeated use
Structure/ texture	Good texture	Dry
	Like chicken	Sticky
	Granular	Soft
	Crispy crust	Spongy
		Hard
		Compact/dense
		Not-tender
		Bad mouth feel
		Tough
		Uniform
		Squeaks between teeth
Part 3		
Structure/ texture	Resembles minced meat	Soft (no resistance in the mouth)

Consumers indicated that they liked this part of the discussion because it made them imagine what a meal with meat substitutes could taste like. They discussed the appropriateness of the use of meat substitutes in the different dishes. This elicited sensory attributes that had not been generated during the general part of the focus groups (table 2.5). The fact that participants mentioned different wanted and unwanted sensory attributes suggests a support for our hypothesis that the appropriateness of meat substitutes in a meal influences the acceptance of meat substitutes. In a quantitative consumer study of the appropriateness of meat substitutes in meals, we also found support for this hypothesis. Both meal context and appropriateness influenced the acceptance of meat substitutes (Elzerman, *et al*. 2011).

Part 3: Sensory session - During the last part of the focus groups, the sensory session, two pasta dishes with Italian tomato sauce were tasted. The two dishes differed only in the meat substitute that was used in the sauce; minced tofu and minced Quorn®. Most participants said that they liked the sample they had tasted. They seemed more positive about the meat

substitutes they had tasted than they were about meat substitutes in general during the first parts of the focus group discussions. This could mean that their low expectations of meat substitutes were not confirmed. Two remarks that were made about the meat substitutes in the pasta dishes were 'it resembles minced meat' (according to the appearance, taste, and texture) and 'it has a weak texture' (no resistance in the mouth). This last remark was seen as a negative aspect of the meat substitutes.

Table 2.5   Appropriate and inappropriate sensory attributes for meat substitutes in different dishes, generated in part 2 of the focus group discussions

	Appropriate	**Inappropriate**
Rice	Neutral	-
Spaghetti	Mince	-
Soup	Soft	-
	Crispy	
	Spicy	
Salad	-	Rubbery when eaten cold
Pizza	Spicy	Special preferences for pizza
Wrap	-	-

Participants reported that they liked the fact that a taste session was part of the focus group and especially consumers who had only little experience with meat substitutes found it easier to give sensory attributes after the taste session. However, if the all the elicited information of the seven focus group discussions is taken together, only a few extra attributes were generated after the taste session. A few participants in some of the focus group discussions were very involved with meat substitutes and had a strong opinion about these products. For these participants it was not necessary to try meat substitutes in order to elicit sensory attributes. For logistical reasons, we did not serve more samples; if we had done so, this part of the discussion might have generated more attributes. The participants might have been more interested in meat substitutes and new foods in general than the general Dutch population. Although vegetarians could not take part in this study, several ex-vegetarians participated. Vegetarians have different purchase motives for foods than non-vegetarians (Hoek, 2004). Ethical and health aspects of meat substitutes were mentioned often during the focus groups, but these could be less important for the general population of Dutch consumers.

These focus group discussions gave more insight into consumer wishes regarding meat substitutes and directions for new product development. This type of research is an important step in the new product development process, as part of idea generation and concept testing (Meyer, 1984). It is important to take consumer beliefs about quality into account in the early stages of product development, since consumer perception of product quality may be more important than the actual quality and properties of the product (Shepherd, 1999).

2.4   Conclusions

- Consumers (The participants) mentioned many general and sensory aspects of meat substitutes
- Not all meals were found appropriate for meat substitutes
- The two extra parts of the focus group discussions (the part on appropriateness and the sensory session) seemed useful because some extra sensory attributes were generated and participants liked these parts of the discussion.

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CHAPTER 3

Appropriateness, acceptance and sensory preferences based on visual information: A web-based survey on meat substitutes in a meal context

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Abstract

This study aimed to investigate the appropriateness, attractiveness, use-intention and (un) desirable sensory properties of meat substitutes in different dishes based only on visual information. A web-based survey was developed to let consumers assess the use of meat substitutes in different dishes. The survey consisted of 38 key questions with subdivisions and was completed by 251 respondents. Six different dishes (spaghetti, rice, wrap, pizza, pasta salad, and soup) were rated for their appropriateness for the use of meat substitutes. Subsequently, appropriateness, attractiveness, and use-intention were rated based on photographs of the six dishes prepared with meat substitutes that differed in shape and appearance. Respondents also had to indicate (un)desirable sensory properties of meat substitutes for every dish. Spaghetti, rice and wrap were more appropriate for the use of meat substitutes than the other dishes. The most appropriate meat substitute-meal combinations were those that are similar to common Dutch meal combinations (e.g. spaghetti with mince and rice with pieces). Attractiveness and intention scores were in line with the appropriateness scores. Furthermore, we found that current users of meat substitutes and younger respondents gave higher appropriateness ratings. This study demonstrates that appropriateness of meat substitutes in a dish is related to attractiveness and use-intention and that meal context should be taken into account in the development of new meat substitutes.

3.1   Introduction

Meat is an important protein source in the Western diet. In Asian and African countries daily meat consumption is also becoming more common, and subsequently the global meat production keeps on growing (Aiking, 2011; Smil, 2002). An increasing number of studies and literature indicate that the production of meat is not very efficient regarding the use of land, water and other resources, and the emission of greenhouse gases (as reviewed in Vinnari and Tapio, 2009 and Aiking, 2011). The combination of increased meat consumption and the environmental impact requires the investigation of alternative protein sources.

Several different types of alternative protein sources have been used to develop new food products that can replace meat in the consumers' meals. Some products have been around for a long time, like tofu, a soy product that originates from Asia. Tofu became popular among vegetarians in the West since the middle of the 20th Century (Courtine, 1984; Shurtleff & Aoyagi, 2001). Current meat substitutes can be made from legumes (such as soy, lentils, (chick) peas or lupins), wheat, rice and egg protein that are ground into meal or processed into protein isolates or protein concentrates (Broekema & Smale, 2011). Besides plant-based meat substitutes, fungus-based products (Quorn®) were introduced in Europe in the 1990ies and the USA in 2002. A newer type of meat alternative is Valess®, a product based on dairy and algae that was introduced in 2005 and is available in several European countries. The use of insects for the development of meat alternatives is being studied as well (Klunder, Wolkers-Rooijackers, Korpela, & Nout, 2012; Rumpold, & Schlüter, 2013). The success of new food products depends on their consumer acceptance, which is a result of a combination of taste, familiarity, and whether or not they meet consumers' expectations (Wansink, 2002; van Trijp & van Kleef, 2008). Consumer studies suggested that meat substitutes should either resemble meat or should be products that are very different from meat and have their own distinct identity (Hoek, van Boekel, Voordouw, & Luning, 2011; Elzerman, van Boekel, & Luning, 2013). The problem with meat substitutes that do not resemble meat is that consumers may not recognize them as such and therefore do not purchase them instead of meat. In order to realize the environmental benefits of purchasing meat substitutes, it is essential that the substitutes are purchased instead of meat, not as an additional product, thereby diminishing demand for meat products. In the Netherlands, meat is traditionally eaten as a separate meal component, although pasta and rice dishes with meat ingredients in a sauce have also become common (Jobse van Putten, 1996; Schösler, de Boer, & Boersema, 2012). Due to the different structures of plant proteins and meat proteins, it is not yet feasible to mimic meat chops with plant proteins. Meat substitutes might therefore be more successful as 'ingredients' (in the form of small pieces or mince) in a meal context than as 'separate meal components' (for the replacement of large cuts of meat) (Aiking, 2006).

Previous studies indicate that meal context plays an important role in consumer acceptance of meat substitutes. During focus group discussions consumers indicated that some dishes were more appropriate for the use of meat substitutes than others (Elzerman et al, 2013). A

Central Location Test (CLT) showed that consumers gave different ratings to different meat-substitute-meal combinations (Elzerman, 2011).

Studying meal context rather than testing separate food items is closer to the real-life eating situation. However, only a few other studies on the influence of meal context on consumer acceptance have been published. Reasons for this may be the complexity of the design and logistics, together with the fact that in research that is closer to the 'real world' it is more difficult to control the stimulus. It is, however, important to find a balance between control and realism (Meiselman, 2013). Whether or not consumers tested food items separately, rather than as part of a meal influenced the consumer ratings of the food items (King, Weber, Meiselman, Nan, 2004, and King, Meiselman, Hottenstein, Work and Cronk, 2007). A repeated exposure study showed that meal context was important for the long-term acceptance of meat substitutes (Hoek, Elzerman, Hageman, Kok, Luning, & van Boekel, 2013).

A CLT with hot meals is a very time-consuming, expensive and complicated consumer study and the number of samples that can be tested by participants before they are satiated is limited. For product development of meat substitutes, it would be more efficient to assess the appropriateness of meat substitutes in a broad range of dishes and in a large consumer sample before starting a consumer taste test. An Internet survey using photographs of the dishes could be an instrument for appropriateness evaluation, and even photographs of the uncooked meat substitutes could be included to create a more realistic assessment situation for respondents.

The objective of this study was to gain insight into the appropriateness, attractiveness, use-intention and sensory preferences of meat substitutes in different meal contexts based on visual information.

3.2   Materials and methods

Subjects

For this survey, we used a non-random convenience sample, aimed to collect data from respondents with various backgrounds in terms of socio-demographics and habitual consumption of meat and meat substitutes in order to compare subgroups. 251 consumers completed the questionnaires, of which 66% were recruited via advertisements on five Internet sites and newspapers and accessed the questionnaire via a web address. To avoid bias as a result of Internet access or computer skills, a part of the respondents (34%) was recruited in a public library in a city in the Netherlands. Visitors entering the library were randomly approached and were asked to participate in a questionnaire on meals by Wageningen University. A researcher assisted persons with no or little computer experience.

Assistance with the completion of the questionnaire was provided to $\pm$ 20% of the library respondents. Chi-square tests showed that the recruitment method yielded different groups of respondents. Respondents that were recruited in the library were generally older (X^2 (2) = 99.1, p< 0.001), were lower educated (X^2 (2) = 53.7, p< 0.001), their meat consumption was higher (X^2 (4) = 12.8, p= 0.012), and their meat substitute consumption was lower (X^2 (3) = 22.0, p< 0.001).

All respondents were living in the Netherlands and their mother tongue was Dutch. The sample characteristics are shown in table 3.1.

Dishes and meat substitutes

Six different types of dishes were selected to study the effect of meal context on the appropriateness and attractiveness of meat substitutes. The dishes differed in their ingredients, usage, temperature, texture, and newness. The dishes included: a main course soup (mostly a liquid dish), a pizza (meat substitutes as a topping), spaghetti with tomato sauce (meat substitutes in a sauce), a pasta salad (a chilled dish), rice with curry (meat substitutes in sauce), and a wrap with Mexican filling (a less common of dish in the Netherlands). In this study, the terms dish, meal combination and meal context refer to the type of dish in which a meat substitute can be eaten.

The products that were used were all meat substitute 'ingredients' that can be used in a sauce or in a dish and they were selected based on their differences in appearance in terms of color, shape and size. We gave these meat substitutes different names based on their shape: 'mince' was a granular, dark-brown product, like minced meat; 'strips' were lighter brown with a rectangular shape; 'pieces' had a white color and a more round, irregular form and looked a bit like chicken; 'slices' had a brownish color and looked like pepperoni; 'cubes' were brown with a square/cubic form. The meat substitutes were commercially available in the Netherlands, but there was no reference to brand names of the products in the questionnaire or the origin of the ingredients of the meat substitutes.

Table 3.1   Sample characteristics (N=251)

		N	%
Gender	Male	79	31
	Female	172	69
Age	Between 15 and 34	172	69
	Between 35 and 54	42	17
	Between 55 and 79	37	15
Education level[1]	Low	35	14
	Medium	103	41
	High	107	43
	Not indicated/other	6	2
Meat consumption	Never	54	22
	< 1x per month	8	3
	1-8x per month	23	9
	2-5x per week	112	45
	6-7x per week	54	21
Meat substitute consumption	Never	44	18
	< 1x per month	91	36
	≥ 1x per month; < 1x per week	63	25
	≥ 1x per week	53	21
Recruitment	Online	166	66
	Public library	85	34

[1] Education levels: *Low*: From primary education up to Pre-vocational education (Dutch: VMBO, MAVO); *Medium*: Secondary vocational education (Dutch: MBO), Senior general secondary education (Dutch: HAVO), and pre-university education (Dutch: VWO); *High*: Higher professional education (Dutch: HBO) and University.

Development of the web-based survey

A web-based survey with descriptions and photographs of dishes with meat substitutes was used to study the appropriateness, attractiveness, use-intention, and (un)desirable sensory properties of meat substitute products in several dishes. The outcome of focus group discussions performed earlier was used in the design of this survey. These focus groups dealt with the use, acceptance, and appropriateness of meat substitutes and generated (sensory) consumer language on this topic (Elzerman *et al*, 2013).

Before starting with the actual survey, we performed a pre-test with 13 university employees who filled out the questionnaire either at home or at the university. Adjustments to the draft version of the questionnaire were made based on their comments.

Questionnaire items

The survey consisted of 38 questions with subdivisions (in total 108 items). The first page informed the respondent about the purpose of the survey: '…Wageningen University would like to assess consumer wishes with respect to meat substitutes, also when you do not use these products…'. After this, an estimation of the time needed to complete the questionnaire was given (30 minutes). A schematic overview of the structure of the survey is shown in figure 3.1.

Personal characteristics

Date of birth, *gender* and *education level* were indicated using multiple-choice answers.

Consumption of meat substitutes and meat

Meat substitutes were described as 'foods that were designed and/or marketed to replace the function of meat in a meal'. Examples given were: Quorn™, vegetarian schnitzels, burgers, tofu, tempeh, and stir-fry products. Furthermore, it was specifically stated that meat substitutes did <u>not</u> include fish, eggs, cheese, nuts, or legumes in this survey.

Habitual *meat consumption* and *consumption of meat substitutes* were indicated using multiple-choice answers (see table 3.1). The meat substitute consumption categories were in line with the consumption figures in the Netherlands (de Bakker & Dagevos, 2010; Aurelia, 2002).
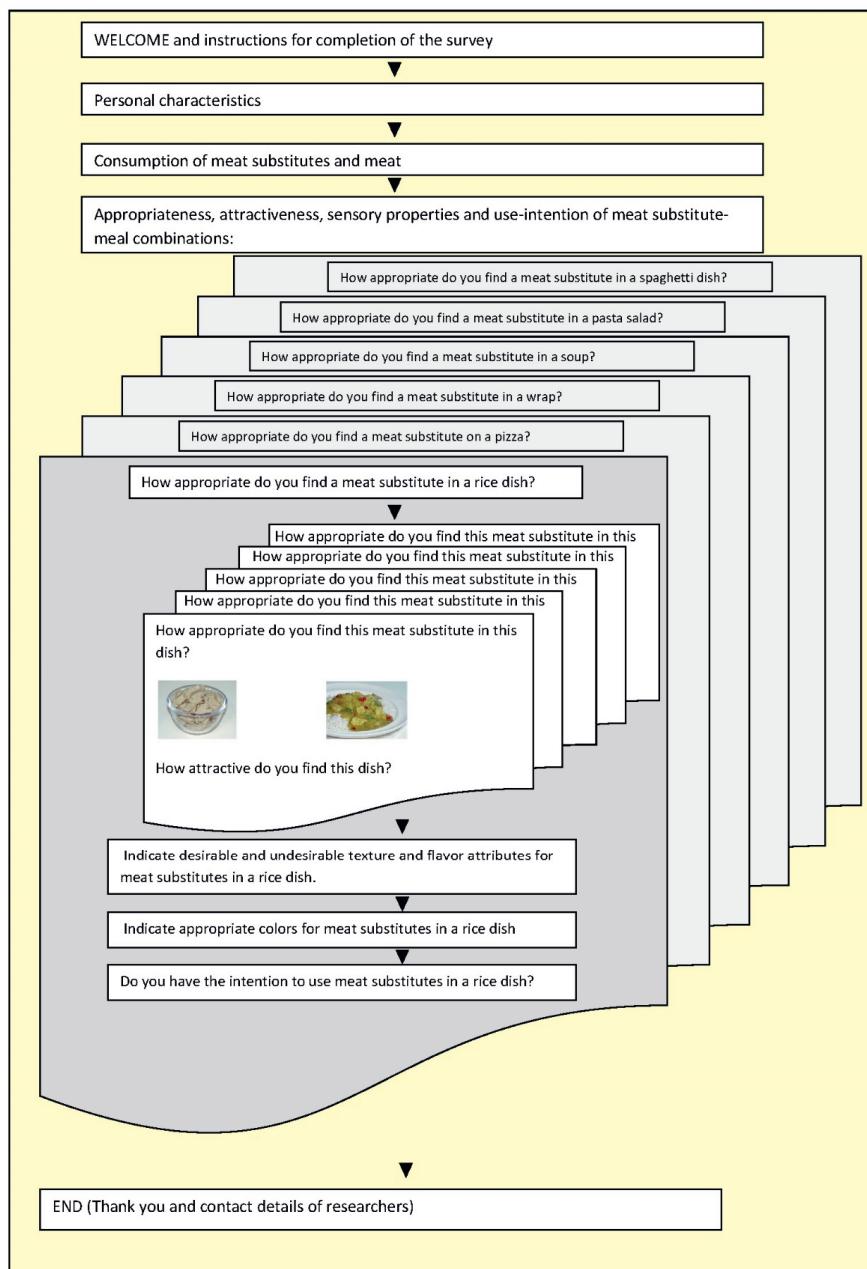
Figure 3.1 Schematic overview of the structure of the web-based survey. The grey 'screens' reflect the questions for every dish and the white 'screens' show the appropriateness and attractiveness questions of a particular meat substitute in a particular dish. The dish and meat substitute in this overview are meant as an example.

Appropriateness and attractiveness of meat substitute-meal combinations

The appropriateness questions were answered on a 100 mm line scale (anchored not at all appropriate - very appropriate).

General appropriateness based on the name of the dish: e.g. 'Indicate how appropriate you find a meat substitute in a spaghetti dish'. This question referred to the whole product category 'meat substitutes', so there was no picture of a particular meat substitute.

Appropriateness of a particular meat substitute in a particular dish based on (1) a photograph of an uncooked meat substitute with the description of the shape of the meat substitute (i.e. mince, strips, pieces, slices or cubes) and (2) a photograph of the meat substitute-meal combination. The question was phrased: 'Indicate how appropriate you find this meat substitute in this dish'.

In the same frame, the *attractiveness* of the displayed meat substitutes-meal combination was also rated on a 100 mm line scale (anchored not at all attractive - very attractive), e.g. 'Indicate how attractive this spaghetti- dish is to you'.

Desired sensory properties

Subsequently, *desirable and undesirable sensory attributes* of meat substitutes in a particular dish were indicated (using tick boxes). These sensory attributes were consumer terms that had been generated during focus group discussions (Elzerman *et al*, 2013).

Texture was described as: 'the feeling that a product gives in the mouth', and texture attributes were: tough, granular, soft, gummy, hard, crispy, dry, smooth, or fibrous.

Flavor attributes were: neutral, meat-like, strong flavor, soy, seasoned, spicy, salty, and Maggi-flavor (Maggi® is a liquid flavor enhancing product).

The respondents could tick the 'positive' box or 'negative' behind each listed attribute, or tick no box at all.

For color, at least one appropriate color had to be indicated for a particular dish. Respondents were shown different shades of white, brown, green, red, and yellow.

Intention to use

'*Intention to use*' was indicated using answer categories ('Yes', 'Maybe', or 'No') and respondents had to explain their answer by typing in an empty text box.

Technical specifications of the questionnaire

The web-based questionnaire was made using the program Frontpage (Microsoft Inc.). The questionnaire contained questions based on food names, and questions based on photographs.

In order to mimic the situation in which consumers buy a meat substitute and use it to prepare a meal at home, respondents were shown photographs of five different uncooked meat substitute ingredients in glass bowls followed by photographs of the different dishes with meat substitutes. By clicking on the picture of a meat substitute ingredient, a picture popped up of a dish prepared with that ingredient and a description of the dish, e.g. 'soup with mince' or 'pasta salad with slices'. The dishes were presented in random order for each respondent. A small text bar showed the respondent's progress throughout the questionnaire.

All photographs in this questionnaire were taken by a professional photographer, ensuring a standard picture layout between products. The composition was made from real foods, but care was taken that the separate ingredients were clearly visible. The photographs of the ingredients and an example of the dishes are shown in table 3.2 (see results section).

The appropriateness and attractiveness questions were answered using a line scale. Before the question was answered, the pointer was situated at the center of the line scale (neutral). Respondents could slide the pointer to the left or right of the center to indicate how appropriate or attractive the meal combination was.

The date and time of the start and finish of the completion of the questionnaire were stored. The average time to fill out the questionnaire was 16 minutes and 4 seconds (range 0:05: 07 to 01:04:06).

It was not possible to skip answers in the web-based questionnaire. Unfortunately, in the transfer of the raw data to the core dataset, a small part of the data was not saved for unknown technical reasons. For comparisons between dishes or meat substitutes, we only included the data of the respondents with no missing data for those dishes or meat substitutes.

Data analysis

The data were analyzed with the software package IBM SPSS Statistics 20. *P*-values below 0.05 were considered statistically significant. Results are expressed as means ± SEM unless otherwise specified.

<u>Appropriateness and attractiveness of meat substitutes in dishes</u>

Appropriateness and attractiveness were analyzed using repeated-measures analysis of variance. When Mauchly's test indicated that the assumption of sphericity had been violated the degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity. Post hoc tests using Sidak correction were used to differentiate between samples.

General appropriateness: The appropriateness of the dishes was compared.

Appropriateness of a particular meat substitute in a particular dish: The appropriateness of the meat substitutes was compared by doing a repeated-measures ANOVA for every type of dish.

Attractiveness of dishes with meat substitutes: A repeated-measures ANOVA was performed for every type of dish.

The relation between general appropriateness and attractiveness was investigated by Pearson's correlation coefficient by calculating a mean of all dishes for appropriateness and attractiveness for every respondent.

Desired sensory properties of meat substitutes

The percentage of respondents who chose a sensory attribute (texture, flavor, color) was calculated for every dish. The differences between the frequencies in which colors were chosen across all dishes were analyzed by Pearson's chi-square.

Intention to use

For use intention, respondents had to choose Yes, Maybe or No for every dish. To illustrate the intention to use different dishes with meat substitutes, we generated a frequency table (% of respondents), that gives an overview of the percentage of respondents in an answer category (Yes, Maybe, No) for spaghetti, rice, wrap, pizza, pasta salad, and soup. Also, an overall intention score for every respondent was calculated as follows: 1 point for No, 2 points for Maybe and 3 points for Yes. This was summed for all 6 dishes (resulting in a hypothetical range from 6 to 18). Consequently, the overall intention scores were subdivided in 3 classes: low overall intention (scores 6 to 9), medium overall intention score (10 to 13) and high intention score (14 to 18).

Consumer groups

Differences between general appropriateness ratings between subgroups of respondents were calculated by using mixed model analyses of variance with the consumer characteristics (gender, and classes for age, education, and meat (substitute) consumption) as between-subjects factors. Differences between the consumer classes for every dish were calculated using Sidak posthoc test.

We also calculated an 'overall general appropriateness score': the mean of the general appropriateness scores of all six dishes. This score was also used to compare the subgroups as well as the two recruitment groups using one-way ANOVA.

For use intention, comparisons were made between subgroups (gender, age classes, education classes, meat substitute consumption classes, vegetarian) for every dish and for the overall use-intention scores by Pearson's chi-square tests.

Table 3.2 Mean appropriateness ratings of meat substitutes in six different meals (soup, pizza, spaghetti, pasta salad, rice, and wrap).

The appropriateness of different meat substitute ingredients (mince, strips, pieces, slices, and cubes) was compared by performing a repeated measures ANOVA per dish.

Dish		Spaghetti	Rice	Wrap	Pizza	Pasta Salad	Soup
Meat substitute ingredient							
	Mince	81.6[a]	50.2[c]	75.9[a]	65.8[a]	48.6[a]	44.4[ab]
	Strips	58.6[b]	61.8[b]	58.0[b]	43.6[c]	50.4[a]	43.6[a]
	Pieces	57.7[b]	66.8[a]	53.5[c]	48.1[b]	50.3[a]	43.8[a]
	Slices	38.9[d]	30.6[d]	29.5[e]	60.7[a]	42.6[b]	48.5[a]
	Cubes	44.4[c]	50.0[c]	43.8[d]	36.5[d]	36.5[b]	38.6[b]
Effect	F	194.56	103.53	196.77	92.88	16.34	6.58
	df^*	3.57	3.08	3.47	3.28	3.44	3.39
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Two values in the same column sharing the same letter did not differ significantly. N= 240; SEM's were between 1.3 and 2.3; $p < 0.05$; 100 mm VAS

* The degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity

3.3   Results

Appropriateness

Figure 3.2 shows the mean scores for general appropriateness of meat substitutes in the six dishes, based on the name of the dish. The various types of dishes differed significantly in general appropriateness for the use of meat substitutes, $F_{(4.57, 1082.95)} = 37.88$, $p < 0.05$.

The appropriateness scores of spaghetti (mean score 67.1), rice (65.3) and wrap (64.0) were significantly higher than the scores for pizza (53.2), pasta salad (48.2) and soup (46.6).
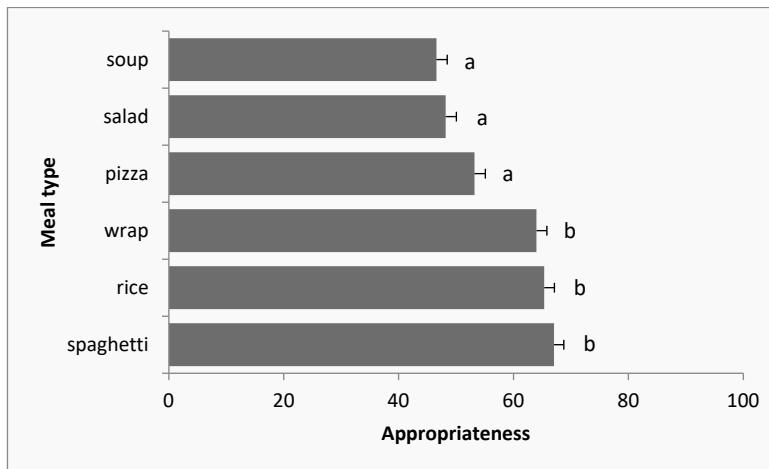
Figure 3.2   Mean general appropriateness ratings (± SEM) for the six dishes. Bars sharing a letter were not significantly different.

Table 3.2 shows the mean appropriateness scores of meat substitutes differing in visual characteristics (mince, strips, pieces, slices and cubes) for the six different dishes. We found significant differences in mean appropriateness scores between the meat substitutes for each meal context. The combination of spaghetti with mince was the most appropriate of all meal context-meat substitute combinations (mean score 81.6). In a wrap (75.9) and on a pizza (65.8) mince had also the highest appropriateness score of all meat substitutes (on pizza, mince was not significantly different from slices (60.7). The rice dish was most appropriate with pieces or strips (66.8 and 61.8 resp.). For pasta salad and soup, the differences between the ingredients were smaller. Slices on a pizza or in a soup had (one of) the highest appropriateness scores in these dishes, whereas in the other dishes slices were (one of) the least appropriate ingredients.

Attractiveness results were similar to the appropriateness ratings and the Pearson's correlation coefficient was 0.900 (the correlation is significant at the 0.01 level). This high correlation is the reason why we do not report the attractiveness ratings.

Sensory properties

Table 3.3 shows desirable and undesirable texture and flavor attributes for a meat substitute in each of the six dishes. The three most positive texture attributes for all dishes were 'smooth', 'soft' and 'crispy' (the order varied between dishes): between 47% and 69% of the respondents indicated these attributes. The most negative texture attributes for all dishes were 'tough' (between 74% and 79 % of all respondents indicated tough as a negative attribute), and 'gummy' (67-75%), although 'dry', 'hard' and 'granular' were also often indicated as negative. Some texture attributes, like 'fibrous' and 'crispy' were both indicated as positive and negative by a large percentage of the respondents.

'Seasoned' was indicated to be a positive flavor attribute by the largest group of respondents for all dishes (between 73% and 86% of all respondents ticked the positive box for this attribute) followed by 'spicy' (54-80%) and 'meaty flavor' (44-59%). Maggi and soy flavors were considered as negative by a high percentage of respondents (44-59% and 47-58% resp.). The flavors 'neutral', 'strong', and 'salty' were found negative attributes by quite large numbers of respondents, but also a lot of respondents had a positive opinion about these attributes.

Brown was the most preferred color for meat substitutes across all dishes ($X^2(8) =1640.435$, $p < 0.001$); see table 3.4.

Use intention

The dishes that received the most positive responses for 'intention to use' were: spaghetti, rice and wrap (51%, 48% and 44 % resp. of the respondents indicated 'yes'; table 3.5). Respondents had to explain their answers by typing in an empty text box. The most mentioned reasons for answering 'Yes' were: 'Meat substitutes are tasty', 'I like to try out new things', 'I am familiar with these products'. Reasons for answering 'No' were: 'I prefer other ingredients/meat in this dish', 'meat substitutes do not look tasty', and 'meat substitutes are not essential in my dish'. Respondents answering 'Maybe' indicated that 'it depends on the taste of the meat substitute' or 'it depends on the dish'.

Table 3.3 Positive and negative sensory attributes for meat substitutes in different dishes. Percentages reflect the part of the respondents that indicated the particular attribute to be positive or negative (N= 251). Multiple attributes could be indicated for each dish. The green areas show for every dish the three texture and flavor attributes that were most often indicated to be positive and the red areas were the most often indicated as negative.

		spaghetti		rice		wrap		pizza		pasta salad		soup	
		positive %	negative %	positive %	negative %	positive %	negative %	positive %	negative %	positive %	negative %	positive %	negative %
texture	Soft	63.0	21.1	60.7	18.6	60.0	19.2	51.2	24.8	62.1	17.3	66.7	17.1
	Smooth	69.3	12.7	62.3	15.0	66.4	12.0	60.0	18.0	57.7	20.2	57.5	19.4
	Crispy	47.0	33.5	51.0	27.1	57.6	25.6	68.3	18.8	58.9	24.6	48.8	34.9
	Fibrous	36.7	38.6	38.1	35.6	36.0	37.6	25.2	45.2	28.2	41.5	35.7	40.1
	Granular	45.0	37.5	18.2	64.4	34.4	47.2	28.4	50.8	19.0	61.7	16.3	63.1
	Hard	13.5	64.5	17.8	58.3	17.6	61.2	22.4	54.0	21.0	56.0	14.3	59.4
	Dry	12.7	61.8	18.2	57.5	14.4	62.8	15.2	61.2	14.9	62.9	14.3	66.9
	Gummy	7.6	75.3	9.3	71.7	6.8	73.2	5.6	73.6	8.5	69.8	11.1	67.1
	Tough	8.8	75.7	12.1	73.7	8.0	78.8	8.4	75.0	7.3	76.2	5.6	77.4
flavor	seasoned	84.9	3.2	81.0	7.3	85.6	3.6	81.6	6.8	72.6	11.7	75.8	11.1
	Spicy	75.7	10.4	70.9	12.1	79.6	7.2	72.8	12.0	54.0	24.2	63.5	19.0
	meaty	58.6	23.1	52.6	26.7	56.0	24.0	54.0	24.8	43.5	31.5	55.6	25.8
	Salty	33.9	40.2	31.6	39.7	32.4	40.8	34.4	38.8	34.3	39.1	41.7	33.6
	neutral	35.9	34.7	39.7	30.4	33.2	39.2	29.6	38.4	44.0	30.6	38.1	36.5
	Maggi	17.5	54.2	16.6	51.8	13.6	58.8	11.6	56.4	14.5	54.4	31.7	43.7
	strong	34.7	37.5	37.7	33.2	44.8	26.8	45.6	28.0	29.4	40.7	31.3	41.7
	Soy	17.5	50.2	25.1	47.4	19.2	49.2	10.0	58.4	16.5	53.2	19.4	57.0

Table 3.4 Indicated colors for meat substitutes in different dishes. Percentages reflect the part of the respondents that chose a particular color to be appropriate (N= 251). At least one color needed to be indicated for each dish.

	spaghetti	rice	wrap	pizza	pasta	soup
	%	%	%	%	%	%
White	12	33	16	10	28	14
Brown	84	73	84	77	64	79
Green	10	10	13	12	19	13
Red	36	22	30	51	37	38
Yellow	24	47	35	25	39	31

Table 3.5 Intention to prepare a dish with meat substitutes (yes, maybe, no) and the four most frequently mentioned motives for each dish.

Spaghetti	Rice	Wrap	Pizza	Salad	Soup
YES (N=129, 51%)	**YES (N=120, 48%)**	**YES (N=110, 44%)**	**YES (N=72, 29%)**	**YES (N=66, 26%)**	**YES (N=71, 28%)**
m.s. tasty (29x)	m. s. tasty (30x)	m. s. tasty (27x)	m.s. tasty (12x)	m. s. tasty (15x)	try out (19x)
familiar with m.s. (18x)	familiar with m.s.(20x)	try out (14x)	try out (8x)	try out (10x)	m.s. tasty (14x)
try out (15x)	good combination (11x)	familiar with m.s. (12x)	convenience (3x)	good combination (6x)	nutritive value (5x)
good combination (11x)	due to sauce (10x)	good combination (8x)	nutritive value (3x)	as a subst. for meat (4x)	filling (5x)
MAYBE (N=70, 28%)	**MAYBE (N=71, 28%)**	**MAYBE (N=76, 30%)**	**MAYBE (N=77, 31%)**	**MAYBE (N=79, 31%)**	**MAYBE (N=71, 28%)**
with mince (12x)	try out (13x)	try out (15x)	m (s) not essential (10x)	try out (11x)	depends on the taste (9x)
try out (10x)	depends on the taste (10x)	with mince (11x)	depends on the taste (8x)	m. (s.) not essential (8x)	try out (8x)
depends on the taste (8x)	depends on the dish (6x)	depends on taste (7x)	try out (6x)	prefer other ingredients (8x)	m.(s) not essential (8x)
m.s. tasty (6x)	m.s. not tasty (5x)	m.s. tasty (5x)	m. s. tasty (6x)	depends on taste (7x)	m.s. not tasty (7x)
NO (N=52, 21%)	**NO (N=56, 22%)**	**NO (N=64, 25%)**	**NO (N=101, 40%)**	**NO (N=66, 26%)**	**NO (N=110, 44%)**
preference for meat (18x)	preference for meat (17x)	preference for meat (17x)	prefer other ingredients (20x)	m. s. not tasty (17x)	m. s. not tasty (30)
m.(s.) not essential (10x)	m. s. not tasty (9x)	m. s. not tasty (13x)	m.(s) not essential (16x)	m. (s.) not essential (17x)	m. (s.) not essential (24x)
m. s. not tasty (7x)	prefer other ingredients (6x)	do not like wraps (9x)	m. s. not tasty (11x)	do not like pasta salad (17x)	preference for meat (20x)
prefer other ingredients (4x)	do not like rice (6x)	other ingredients (6x)	never prepare pizza (11x)	prefer other ingredients. (17x)	do not like soup (12x)

Abbreviations: m.s= meat substitute; subst.= substitute; m.(s) = meat or meat substitute

Consumer groups

We looked at consumer characteristics (age, gender, meat (substitute) consumption) to see if different types of consumers had different opinions about the acceptance and sensory characteristics of meat substitutes in dishes.

We found differences between meat substitute consumption categories in general appropriateness (overall the dishes): $F_{(3,247)} = 9.12$, p=0.000 (table 3.6). Spaghetti, rice and wrap were scored significantly higher on general appropriateness by 'medium users' and 'heavy users' of meat substitutes (table 6). Respondents who had never used meat substitutes rated the appropriateness significantly lower than the other user groups for spaghetti, rice and wrap. There were only minor differences in the appropriateness scores of the different user groups for the particular meat substitute -meal combinations (data not shown).

Chi-square tests on intention-to-use categories showed that there was a significant difference between meat substitute consumption groups ($X^2_{(6)}$ = 21.3, p= 0.002). Almost 60 % of the respondents in the high overall intention category were medium or heavy users of meat substitutes. However, the difference in intention between the meat substitute consumption groups was only significant for spaghetti, rice and wrap: the majority of the current users (medium and heavy users) intended to prepare these dishes with meat substitutes.

For different age categories (table 3.7), we found that overall general appropriateness was rated lower by older respondents (age group 55-80); $F_{(2, 248)} = 3.91$, p = 0.021. We also found that soup, pizza and spaghetti did not differ across age groups, but rice and wrap were rated higher by the youngest age group, and the age group 35 to 55 years gave the highest appropriateness ratings to salad. No difference was found for overall use-intention classes between the different age categories (data not shown).

The overall general appropriateness score (mean overall dishes) was significantly lower in the group that was recruited in the library (53.1 ± 2.4) than in the group that was recruited via web pages or newspapers (59.7 ± 1.3), $t_{(250)}$ = 2.7, p=0.009. We did not find differences between these two groups for use intention.

No differences were found for gender and different education classes both for appropriateness and use intention.

Table 3.6   Mean general appropriateness scores (SEM) of meat substitutes in the six dishes for the four categories of meat substitute consumption. Consumption categories were compared by dish and ratings within the same row sharing a letter in the superscript were not significantly different.

Dishes	Meat substitute consumption category[1]								P value
	Non-users		Light users		Medium users		Heavy users		
Spaghetti	51.2[a]	(3.9)	66.3[b]	(2.7)	68.5[bc]	(3.2)	80.3[c]	(3.6)	0.000
Rice	46.6[a]	(4.0)	64.6[b]	(2.7)	68.7[bc]	(3.3)	78.3[c]	(3.7)	0.000
Wrap	49.2[a]	(4.2)	60.6[ab]	(2.8)	68.3[bc]	(3.4)	78.3[c]	(2.8)	0.000
Pizza	47.9[a]	(4.5)	55.1[a]	(3.1)	51.1[a]	(3.7)	57.5[a]	(4.2)	0.393
Salad	46.6[a]	(4.5)	47.6[a]	(3.1)	47.2[a]	(3.7)	51.5[a]	(4.2)	0.928
Soup	37.8[a]	(4.5)	47.6[a]	(3.1)	47.2[a]	(3.7)	52.2[a]	(4.2)	0.391
Overall[2]	46.6[a]	(4.3)	57.0[b]	(2.9)	58.5[bc]	(3.5)	66.4[c]	(3.8)	0.000

[1]Meat consumption categories: Heavy users =once a week or more, Medium users=once a month or more, but less than once a week, Light users= less than once a month, and Non-users=never

[2]'Overall'= Mean of appropriateness scores of the six dishes

Table 3.7   Mean general appropriateness scores (± SEM) of meat substitutes in the six dishes for the three age categories. Age categories were compared by dish and ratings within the same row sharing a letter in the superscript were not significantly different.

Dishes	Age category						P-value
	15 to 35		35 to 55		55 to 80		
Spaghetti	68.6[a]	(2.0)	69.5[a]	(4.2)	56.7[a]	(4.5)	0.082
Rice	67.6[a]	(2.1)	67.7[ab]	(4.4)	51.4[b]	(4.6)	0.008
Wrap	67.4[a]	(2.2)	56.8[ab]	(4.5)	56.5[b]	(4.7)	0.011
Pizza	53.9[a]	(2.3)	55.5[a]	(4.7)	48.0[a]	(5.0)	0.512
Salad	47.0[a]	(2.2)	59.1[b]	(4.6)	41.0[a]	(4.9)	0.014
Soup	46.6[a]	(2.2)	52.2[a]	(4.7)	41.1[a]	(5.0)	0.226
Overall[1]	58.5[a]	(2.2)	60.1[a]	(4.5)	49.1[b]	(4.8)	0.021

[1]'Overall'= Mean of appropriateness scores of the six dishes

3.4   Discussion

This study used a web-based survey to investigate consumer opinions regarding meat substitutes in a meal context based on visual information. The overall aim was to gain insight in the appropriateness, attractiveness, use intention and sensory preferences of meat substitutes in dishes.

Appropriateness, attractiveness and intention-to-use

Spaghetti, rice and wrap were more appropriate for the use of meat substitutes than the other dishes. This is in line with an earlier focus group discussion study where respondents also found meat substitutes most appropriate in spaghetti, rice and wrap. In these dishes, the meat substitutes were part of a sauce. Less appropriate dishes were pizza, pasta salad and soup and respondents indicated that they had special preferences for pizza topping (vegetables, fish, or pepperoni) and soup (no meat or small meatballs) and that meat substitutes should not be eaten cold (as in a pasta salad) (Elzerman *et al*, 2013). The meat substitutes differing in visual characteristics (mince, cubes, pieces, strips and slices) scored differently on appropriateness in the six different dishes. This suggests that the meal combination determines whether or not a meat substitute ingredient is appropriate, and that it is not a general acceptance or rejection of a particular meat substitute. These findings are in agreement with a previous Central Location Test (Elzerman *et al*, 2011), showing also that spaghetti with mince (mean appropriateness score 79.3 $\pm$ 1.7) was the most appropriate combination and rice was most appropriate with pieces (68.2 $\pm$2.1). Soup and salad received slightly higher appropriateness ratings in the CLT when compared to the web-based survey described here (soup with mince: 53.0 in CLT versus 44.4 in this survey; soup with pieces: 64.2 vs. 43.8; salad with mince: 58.4 vs. 48.6; salad with pieces: 58.6 vs. 50.3). In the CLT, respondents had a plate with the dish in front of them and thus could both see and smell the dishes with meat substitutes when rating the appropriateness (before tasting). In the present study, respondents could only see photographs of the dishes. Also, a photograph of the uncooked meat substitute preceded the assessment of the dish with meat substitutes, whereas in the CLT, the uncooked product was not shown. The view of the uncooked product leads to expectations of liking that could influence the assessment of the whole meal (Hurling, & Shepherd, 2003). We used the photographs of the uncooked products to get a more realistic situation in which a consumer would first see the uncooked meat substitutes and use them to prepare a dish. The uncooked products were not rated because of the length of the questionnaire.

Consumers seem to follow a process of categorization when assessing new products (Michaut, 2004). If there is substantial but not perfect overlap ('moderate incongruity'), consumers will attempt to 'force fit' the new product into an existing category (assimilation). This means that consumers would judge these new products like if they were from that category. The meat substitutes mince, pieces and slices looked much like minced meat, chicken fillet pieces and

small slices of salami respectively. The meal combinations spaghetti with minced meat, rice with chicken pieces, and pizza with salami are familiar to Dutch consumers. This might be an explanation to the higher scores of these meat substitute-meal combinations. The acceptance of an unfamiliar food is determined by how it relates to familiar foods that are part of an individual's current diet (Tuorila, Meiselman, Cardello, & Lesher, 1998). Van Trijp, & van Kleef (2008) discuss the 'moderate incongruity effect' in the success of new food products. Moderate levels of newness will be associated with more positive affect than either low or very high levels of mismatch. This mismatch is probably what we see in the appropriateness scores of the cubes that might have looked too different from any known (meat) product. Interesting here is that strips receive slightly higher appropriateness ratings in some dishes, although strips also do not resemble any meat products. It is quite likely that strips have been recognized as tofu products, which have been on the market much longer than cubes, leading possibly to different expectations and categorization process.

Several papers discussed the relation between appropriateness and acceptability (e.g. Cardello & Schutz, 1996, and Cardello, Schutz, Snow & Lesher, 2000). It was suggested that the term appropriateness implies a more normative aspect of how well the food fits in the contextual situation in which it is eaten, whereas in the case of liking/attractiveness there is more emphasis on the hedonic quality of the experience. Both measures seem to tap similar, although not identical underlying attitudinal constructs. The high correlation (0.90) we found between appropriateness and attractiveness suggests that meal context and appropriateness are important for the acceptability of meat substitutes; an inappropriate combination produced an unattractive dish. The correlation we found was a bit higher than the correlation of 0.83 between mean appropriateness ratings and hedonic ratings found by Cardello & Schutz (1996). They studied the appropriateness of both foods that were tasted and conceptual products that were described and these products were rated for their acceptability and appropriateness in different use situations. The correlation might have been lower than in our study because of the higher variation in products and situations.

The dishes that received the highest appropriateness scores also had the highest frequency of respondents indicating 'yes' to intention to use (spaghetti, rice and wrap). However, still quite a large part of the respondents (at least 21%) had no intention to use these meat substitutes in a dish. What it is that these reluctant respondents need to change their opinions about meat substitutes should be further investigated.

Summarizing, for new product development, evaluation of the appropriateness in a meal context seems to be of importance, and this should not only include 'general appropriateness' at the meal-concept level (e.g. meat substitutes in spaghetti), but also different variants should be tested (e.g. spaghetti with mince).

Sensory preferences

Most of the respondents in our study preferred certain product characteristics that are similar to meat (meat-like flavor, brown color). This was also reported by Sadler (2004) and Hoek *et al* (2011) for non-vegetarian consumers. We found that soy flavor was indicated to be a negative sensory attribute of meat substitutes, which was also reported by Wansink, *et al* (2000) for soy products (like tofu and other meat substitutes). They found that a soy label on the package negatively influenced sensory perceptions of products, even when the product did not contain soy. Well-known consumer sensory preferences for *meat* are: good taste, appearance (color, visible fat), tenderness, and juiciness (Grunert, 1997; Resurreccion, 2003). It would be interesting to know to what extent consumers also expect meat substitutes to have these properties.

Differences between consumer groups

Medium and heavy users of meat substitutes gave higher ratings than non-users for general appropriateness and fell more often in the high intention category for the use of dishes with meat substitutes. We found that 49% of these medium and heavy users of meat substitutes had a meat consumption of less than once a month (so they almost had a vegetarian diet), whereas 43% of the non-users of meat substitutes ate meat on 6 to 7 days a week. It seems that the medium and heavy users of meat substitutes do not miss meat in the dishes that we presented to them. Therefore, they might have been more positive about the appropriateness of the combinations. The non-users seem to still have barriers toward these new foods and are reluctant to try them. In light of the transition that is needed from high meat consumption toward a more plant-based diet, specific barriers that consumers experience regarding meat substitutes should be studied. Van Trijp and van Kleef (2008) listed several factors in the adoption of new products by consumers, like perceived meaningfulness (usefulness to target users) and newness (uniqueness) and the amount of change that is needed in existing behavioral patterns. A new product should be novel enough to induce curiosity, but familiar enough not to induce fear and neophobia. Familiarity may also have played a role in the differences in appropriateness and use-intention between the meat substitute consumption groups. Repeated exposure may have led to the higher acceptance ratings of the current users of meat substitutes. This was also shown by Hoek *et al* (2013), who reported a mere exposure effect after repeated consumption of meat substitutes (2 times a week for 10 weeks). This suggests that the more reluctant consumers might also positively change their minds about meat substitutes after repeated exposure to these products. Food companies, government programs or media could promote repeated consumption of meat substitutes. Another explanation for the differences between the ratings of the meat substitute consumption groups can be that the current users of meat substitutes are more eager to try new foods. Food neophobia is a person's reluctance to consume either new or unusual foods, based on

one's culture and current diet (Fischler, 1988; Stallberg-White, & Pliner, 1999). We did not measure this tendency, which can be done by using the Food Neophobia Scale (Pliner & Hobden, 1992), but it is possible that current users of meat substitutes are less neophobic. Tuorila, *et al* (1994) also found that 'neophilics' rated novel foods higher than neophobic respondents.

Regarding the sensory properties, most heavy users of meat substitutes found 'meat-like flavor' a negative attribute (58-70% for the different dishes) compared to the whole group of consumers (23-32%). More heavy users (34-53%) felt that 'soy flavor' was a positive attribute compared to 10-25% of the whole group of respondents. Concluding, the use-frequency of meat substitutes seems to be a factor in the consumers' acceptance and preferences of these products, implicating that the market of meat substitutes consists of several segments and that different products or dishes should be marketed to serve these segments.

Older respondents had lower overall general appropriateness ratings and rated some of the dishes lower than the younger age categories. This is not in line with the findings by Pliner and Salvy (2006), who found that younger adults accept fewer novel foods than older adults. Tuorila, Lähteenmäki, Pohjalainen, & Lotti (2001) however, found that food neophobia increased with age.

Methodological evaluation

To our knowledge, this has been the first study using an Internet questionnaire to reveal consumers' opinions on the applicability of meat substitutes in dishes.

We used this survey to screen the acceptance (appropriateness, attractiveness and use intention) of different combinations of meat substitutes in a meal context. We included interactive questions where the respondents first saw the uncooked meat substitute ingredients and after clicking on the photograph they saw a dish that was made with that ingredient. This type of survey enabled respondents to answer the questions at home at the time that suited them. This step could be used as one of the early steps in a new product development process, after idea generation and prototype development. Van Trijp and van Kleef (2008) indicated that consumers can be involved in the screening of new product ideas and not so much in the idea generation part of new product development. With the questions about desirable sensory attributes, we asked more of the imagination of the respondents. Respondents agreed to a large extent on the desirable and undesirable sensory attributes and colors for the meat substitutes across all dishes. Thus, one could suppose that some attributes are universal in eliciting positive or negative responses by consumers. Undesirable properties such as tough, dry and hard are common undesirable attributes for meat (Grunert, 1997; Resurreccion, 2003). However, it is possible that asking to indicate sensory attributes is a step too far for consumers, although these attributes were mentioned during consumer focus group discussions (Elzerman, 2013). As a continuation of this study, a comparison study could

be designed where the appropriateness of *all* product-dish combinations are evaluated both in a web-based questionnaire as well as a CLT. Also, to further improve the survey, the (un)desirable sensory properties that respondents indicated could be checked in a consumption study.

It should be taken into consideration that we used a consumer sample that was not representative of the consumers in the Netherlands. Our sample had more women and the respondents were younger, higher educated, ate less meat and more meat substitutes than the general Dutch population. The advertisements that we used for the recruitment of respondents might have attracted consumers that were more interested in meat substitutes. We realized that a web-based questionnaire would not be easily found and accessed by all Dutch consumers; therefore we also recruited via a public library. The group that completed the questionnaire in the library was older than the online respondents, and therefore the age of the library group was closer to that of the Dutch population (Statistics Netherlands, 2014). The overall appropriateness of the library group was lower than that of the other respondents, so it might be that a larger and more representative sample would show lower appropriateness scores.

Conclusions and implications for the development of meat substitutes

This study investigated the appropriateness of meat substitutes in a meal context based on visual information.

The more promising dishes for the substitution of meat seem to be the ones in which the meat substitutes are used in a sauce (e.g. spaghetti, rice, wrap). The most appropriate meat substitutes were similar to meat in terms of color and shape and the most successful combinations seem to be the ones that are familiar to consumers. Current users of meat substitutes were more positive about the meat substitute-meal combinations than the non-users; it is the challenge of product developers and marketers to expose reluctant meat eaters to these new products by media and tastings, etc. and to give them the right expectations and a positive product experience in order to increase familiarity and appropriateness of meat substitutes.

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CHAPTER   4

Consumer acceptance and appropriateness of meat substitutes in a meal context

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Abstract

The replacement of meat by meat substitutes could help to reduce the environmental burden of our food production systems. However, the acceptance of most meat substitutes is still low. This study investigated the role of meal context on the acceptance of meat substitutes. In a central location test involving 93 participants, meals with meat substitutes were rated on overall liking, product liking (liking of the meat substitute in the meal), appropriateness, and intention-to-use, whereas individual meat substitutes were rated on overall liking. Meat substitutes with similar flavor and texture, but with different shapes (pieces and mince), were rated differently in four meals (rice, spaghetti, soup, salad) on product liking, appropriateness, and intention-to-use, but not differently on overall liking of the meals. Meat substitutes with similar shapes, but different flavors and textures rated differently on overall liking when tasted separately, but did not always differ in product liking when tasted in a rice meal. Appropriateness seemed to be influenced by the appearance of the meat substitute-meal combination, and less by flavor and texture. For the development of new foods (e.g. meat substitutes), more emphasis is needed on consumer evaluation of meal combinations instead of on the sensory properties of the individual product.

4.1 Introduction

Meat plays an important role in the consumption pattern of most European and North-American consumers (FAO, 2004). This can be explained by several factors: (1) meat is perceived as nutritious and healthy (Verbeke, *et al*, 2010), (2) the sensory properties (flavor and texture) of meat are well-liked by many consumers (Grunert, 1997; Bredahl, Grunert & Fertin, 1998, Verbeke *et al* 2010), and (3) the consumption of meat is embedded in the culture of Western countries (de Boer, 2006). Although in some countries, like the Netherlands, meat consumption has stabilized over the last decades, global meat consumption and production have dramatically increased over the years (FAO, 2004). Two important driving forces are the growth of the world population and an increase in meat consumption per capita related to the increase in income in developing countries. Meat production, however, is responsible for environmental pressure such as pollution and unsustainable use of resources, due to the inefficient conversion of plant protein to meat proteins (Pimentel & Pimentel, 2003). With the still-growing world population in mind, it is important to explore possibilities for a more environmentally sustainable food production chain. The replacement of meat by plant-based meat substitutes could be an interesting option; however, this is only a realistic option when consumers accept these new products. One prerequisite for the acceptance of meat substitutes is that consumers can recognize a meat substitute as being a product that should be eaten *instead* of meat. This means that the form and usage of meat substitutes should not be too different from meat (e.g. a shake or a soup would not be recognized as a meat substitute by today's consumers). In focus group discussions that preceded this study, many consumers indicated that they found it important that the appearance of a meat substitute was similar to meat products and that it should be clear how to prepare a meal with meat substitutes (Elzerman, 2006). Other important aspects that are required for the acceptance of meat substitutes are the sensory properties of the products (appearance, taste, and texture). The taste and texture of meat are highly valued by many consumers (Grunert, 1997; Bredahl *et al*, 1998). Especially the juiciness and tenderness are well-liked texture attributes. Meat substitutes do not have to possess the same sensory attributes in order to be liked by consumers, but taste and texture are important characteristics for the acceptance of a product by meat-eaters (Hoek, Luning, Stafleu & de Graaf, 2004).

To mimic large chops of meat (such as steaks) with plant proteins does not seem to be feasible, therefore, the introduction of 'meat substitute ingredients', smaller meat substitutes that will be served as part of a dish (e.g. in a soup, a sauce, or as a topping on a pizza), seems to be more acceptable (Weaver, *et al*, 2000; Aiking & de Boer, 2006). Since these 'meat substitute ingredients' are not eaten separately, but always as part of a dish, the meal context seems to be of crucial importance for the acceptance of these meat substitutes. Context can be defined as all the variables in a particular eating occasion (Meiselman, Johnson, Reeve, & Crouch, 2000). When a food is eaten as part of a meal, 'meal context' refers to all other foods that are part of that meal.

Consumer researchers acknowledge the role of meal context, but it has been the subject of only a limited number of consumer studies, all of these studies using the term meal context as the different menu items (e.g. starter, main dish, potato, vegetable, sweet items) that together form a meal. Studies on 'food item compatibility' (i.e. how well the menu items in a meal interact) are reviewed by Meiselman (1996). Turner and Collison (1988) studied the influence of the acceptance of individual menu items (i.e. dishes) on the acceptance of the whole meal. They found that the main dish had a dominating effect on the acceptance of the meal. More recent studies showed that individual food items (e.g. lasagna, salad, and iced tea) were less accepted than when the same items were served together, as part of a meal (King, et al, 2004; King, et al, 2007). Meal context in the sense of how a food is prepared and used in a dish is the essence of cooking and it seems evident that the type of dish influences the acceptance of a meal ingredient. Already half a century ago this was studied by Eindhoven and Peryam (1959), who looked at food combinations in a dish and how well meat or fish matched with potatoes or vegetables. They concluded that the match of a food combination was in large part independent of preferences for the individual components. However, their study was only based on food names, so no tasting was involved. The match of foods together in a meal context we define as 'appropriateness'. Appropriateness seems to be learned during childhood (Rozin, Fallon & Augustoni-Ziskind, 1985; Rozin, 1990; Roedder John, 1999). The match or appropriateness of a food combination is affected by experiences and expectations of what a dish should look and taste like. To our knowledge, when we look at the dish in which a food is served, appropriateness and meal context (type of dish, type of flavoring) have not been researched before. In the present study, we use the expression 'meal context' for the main dish in a (hot) meal. All other foods or menu items that can be part of a meal (starter, dessert, drinks, etc) were not part of our study.

The objective of our study was to obtain insight into the influence of meal context on the acceptance of meat substitutes.

The research questions addressed in this chapter are:

1. Does meal context influence the acceptance of meat substitutes?

2. Does the appropriateness of a meat substitute in a meal influence the acceptance of meals with meat substitutes?

3. Do meat substitutes that differ in flavor and texture also differ in their appropriateness in a meal?

We hypothesize that meal context influences the acceptance of meat substitutes and that appearance and shape, as well as flavor and texture of meat substitutes, determine the appropriateness in a meal context.

This study was part of a research program called PROFETAS (PROtein Foods, Environment, Technology And Society). This program studied the replacement of meat consumption by environmentally more sustainable plant-based meat substitutes (Aiking, de Boer & Vereijken, 2006). To be able to study consumer acceptance of meat substitutes within the framework of

the PROFETAS program, we used commercially available meat substitutes and the participants in our study were meat-eaters.

4.2   Materials and Methods

Study design

A central location test following a full factorial design was conducted to assess the influence of meal context on consumer responses to meat substitutes. To answer the research questions, the test consisted of two parts (see figure 4.1):

Part 1: Exploring the role of appropriateness and meal context on acceptance

To assess the role of appropriateness, meat substitutes of the same brand and constitution, but with a different appearance and shape (pieces and mince) were served in four different meal concepts (i.e. the type of dish; e.g. a rice dish, spaghetti, soup, salad). Participants evaluated the meal samples on the appropriateness (before and after tasting the meal), overall liking, product liking, and intention to use a dish with meat substitutes.

To answer the question of whether or not meal context influences consumer liking of meat substitutes, the participants also rated individual meat substitutes on overall liking. Individual meat substitutes are defined as meat substitutes that are not used in a meal, but that are tasted separately. The overall liking rates of the different individual meat substitutes were compared to the product liking and overall liking of the meals with meat substitutes.

Part 2: Influence of flavor/texture on appropriateness and acceptance

The role of flavor and texture on the appropriateness of meat substitutes in meals was assessed by using five meat substitutes in the same form (pieces, but from different brands and made of different raw materials) in three rice dishes. The meal concept of the three rice dishes was the same (i.e. white rice with a sauce containing meat substitutes), so we expected consumers to rate these combinations similarly on appropriateness (*before* tasting the dish). The dishes differed in the ingredients and therefore the flavor and appearance of the sauce. Possibly, one type of meat substitute combines better with a certain sauce than another meat substitute. Therefore, these dishes could be rated quite differently on appropriateness (*after* tasting the dish). Participants evaluated the dishes and rated them on appropriateness *before* and *after* tasting the meal, overall liking, product liking, and intention to use a dish with meat substitutes. Individual meat substitutes were rated on overall liking and 'similarity to meat'. The similarity to meat results will be discussed only in the Discussion.

After these two parts of the Central Location Test, we let the participants evaluate the same meals (as described above) with chicken fillet pieces instead of meat substitute pieces. Individual chicken fillet pieces were evaluated as well. This was done to get an idea of the relative heights of the scores of the meat substitutes that were tested in this study. The results of this 'benchmarking' are briefly described in the Discussion section of this chapter.

Part 1	Spaghetti	Soup	Salad	Rice Curry
Meat subst. A-mince	**8 combinations**			
Meat subst. A (pieces)				

				Meat substitute A
				Meat substitute B
	15 combinations			Meat substitute C
				Meat substitute D
				Meat substitute E
Rice Curry	Rice Satay	Rice Sweet & sour		**Part 2**

Figure 4.1   Schematic presentation of the experimental design. The 28 samples that were tested consisted of six individual meat substitutes, eight meat substitute-meal combinations in part 1 of the study and 15 meat substitute-meal combinations in part 2 of the study. The samples of the rice dish with curry sauce and meat substitute A-pieces were used for both part 1 and part 2 of the study.

Sample preparation, presentation, and evaluation

An overview of the samples is shown in table 4.1.

Table 4.1   Labeling, product -, brand names, and main ingredients of the meat substitute samples (based on information from manufacturers).

Meat substitute		Main ingredients
Label	**Product/brand name**	
A	Quorn® pieces	Mycoprotein, egg white
A mince	Quorn® mince	Mycoprotein, egg white
B	Tofu strips (retailer brand)	Soybean curd, sunflower oil
C	Tivall® stir fry pieces	Soy protein, pea protein, sunflower oil, egg protein
D	Goodbite® chicken style	Soy protein, wheat protein, egg protein
E	Vivera® vega stir fry pieces	Soy protein, olive oil

Part 1: Exploring the role of appropriateness and meal context on acceptance

We aimed for meat substitutes that only differed in appearance and form, but were identical in other aspects. Two commercially available meat substitutes with similar ingredients, but different in appearance (color) and form were used: marked as A-pieces and A-mince (the main ingredients are shown in table 4.1). The meat substitutes were prepared just before the start of the session using a standardized procedure. The samples of individual meat substitutes that were served consisted of two tablespoons of mince or eight pieces.

The different meal concepts included in this study were:

- Rice dish: white rice with curry sauce, combined with meat substitutes.
- Spaghetti dish: spaghetti with a tomato-based pasta sauce, combined with meat substitutes.
- Meal soup: a filled Chinese tomato soup, combined with meat substitutes.

The warm components of all the dishes were kept in a water bath installation at 70°C for the duration of the test, and the three components of the dish were combined just before serving the sample.

- Meal salad: cooked and chilled pasta with raw vegetables and yogurt dressing, combined with meat substitutes. The pasta salad was kept overnight in the refrigerator (5 °C) until right before serving the samples.

The choice for these meal concepts was based on the results of focus group discussions on meat substitutes that we performed earlier (Elzerman, 2006). In these focus groups, we also discussed the appropriateness of meat substitutes in different meals. The meal concepts that we have chosen for the present study differed in several aspects:

- *Flavoring* and *ethnicity*: the rice dish and the spaghetti dish are both meals in which the meat substitutes are served in a sauce, but they originally come from different cuisines (the spaghetti dish is inspired by Italian cuisine and the rice dish is based on the Asian cuisine).
- *Substance*: the soup is a meal in which the meat substitutes will be served in a 'fluid' dish.
- *Temperature*: the salad is a meal in which the meat substitutes are served cold, whereas the other meals were served hot.
- *Newness*: The meal salad and the meal soup are newer meal concepts than the spaghetti dish with tomato sauce and the rice dish with curry, which are quite well-known dishes in the Netherlands. Therefore, we expected that consumers did not yet have strict expectations of what are and what are not appropriate ingredients for a meal salad or a meal soup.

Part 2: Influence of flavor/texture on appropriateness and acceptance

Five commercially available meat substitute pieces were used (product names and main ingredients are shown in table 4.1). The samples of the rice dishes that were served consisted

of two tablespoons of cooked white rice with two tablespoons of either curry, satay (peanut sauce), or sweet & sour sauce, combined with eight pieces of meat substitutes. The samples were prepared and kept the same way as the samples in part 1, and the meat substitute pieces were evaluated separately as well as in the three rice dishes.

Each participant needed three sessions to evaluate all of the 28 samples. Therefore, the study lasted ten days within two working weeks. The dishes with meat substitutes were evaluated in the first two sessions and the individual meat substitutes (without the meal context) were served in the third session. Each day around 30 persons were in one session. The evaluation took place between 12 noon and 1 p.m. in the university's dining room, where every participant had his/her own table. Three or four samples were served simultaneously, because of logistical reasons. The samples were given in a balanced order and were judged one by one. Participants were asked to take at least two bites containing meat substitutes.

The samples were evaluated before and after tasting, on several outcome measures (Table 4.2). All questionnaire items were rated on a 100 mm visual analog scale.

Table 4.2   Questionnaire items that were used for the evaluation of the meal samples.

Questionnaire item	Phrasing of the question	Anchors
Overall liking	How much do you like this dish?	dislike very much – like very much
Product liking	How much do you like the meat (substitute) product in this dish?	dislike very much – like very much
Appropriateness	How appropriate do you find the meat substitute in this dish?	not at all appropriate – very appropriate
Intention-to-use	How likely is it that you would prepare this dish with this meat substitute?	very unlikely – very likely

Participants

Participants were recruited in the area of Wageningen (the Netherlands) via posters, flyers, and local newspaper advertisements. Participants were told that they would taste products and meals with meat and/or meat substitutes. Recruited persons who were vegetarians or allergic to the used food components were excluded from participation in this study.

Participants were between 18 and 66 years old (average age was 35, 77% were women, 97% had the Dutch nationality, and 54% had a university degree). The habitual meat consumption was less than once a week for 2 % of participants, once to twice a week for 12 % of participants, three to four times a week for 35 % of participants, and more than five times a week for 51 % of participants. In general, the meat substitute consumption was low, 21 % had never eaten meat substitutes and 21 % had consumed meat substitutes a few times. Meat substitute consumption of less than once a month was 17 %, once a week 19 %, once to twice

a week 19 %, and three times to four times a week 4 %. In the study, meat was defined as meat products that are eaten during a hot meal. Poultry was also defined as meat in this study, while fish and cold cuts were not defined as meat. Meat substitutes were defined as food products that are produced to substitute the function of meat during the hot meal.

Data analysis

Results are expressed as mean ± SEM unless otherwise specified. The data were analyzed using repeated-measures analysis of variance procedures of SPSS 14.0 for Windows and p-values below 0.05 were considered statistically significant. The Greenhouse-Geisser correction was applied when the assumption of sphericity was not met. Post hoc tests (using Sidak correction) were used to differentiate between samples.

4.3   Results

Influence of meal context on acceptance of meat substitutes

Figure 4.2 shows the liking ratings of meat substitutes A-pieces and A-mince when tasted separately and when tasted in a meal context. The individual meat substitutes A-pieces and A-mince differed in overall liking ratings (resp. 71.0 ± 1.9 and 45.8 ± 2.5, p= 0.000). The product liking ratings (i.e. the liking of the meat substitute in the meal) show that A-pieces were also liked better than A-mince in the rice dish and the salad, but not in the spaghetti and the soup. The differences between the meat substitutes were not found when we compared the overall liking of the dishes (rice, spaghetti, soup, and salad) containing these meat substitutes (see fig. 4.3).

Influence of appropriateness on meal acceptance

The appropriateness ratings (*before* tasting) of the eight meat substitute-meal combinations (A pieces or A mince in a spaghetti, rice, salad, or soup dish) were significantly different (F(5.59, 474.87)= 24.51, p= 0.000). When we compared the appropriateness ratings (*before* tasting) of the two meat substitutes (pieces and mince), we found that spaghetti with mince was perceived as the most appropriate combination (79.3 ± 1.7 as opposed to pieces: 52.6 ±2.7, p= 0.000; see Fig. 4.4). Another appropriate combination was rice with pieces (68.2 ± 2.1), which was more appropriate than rice with mince (40.3 ± 2.8, p= 0.000).

In the soup and the salad, pieces and mince were equally appropriate. The pattern of appropriateness ratings, evaluated *after* tasting, was similar to the appropriateness ratings before tasting (not reported). The 'intention to use' ratings were lower than the appropriateness and liking ratings, but the same order and significant differences between combinations with pieces or mince were found (Fig. 4.5).
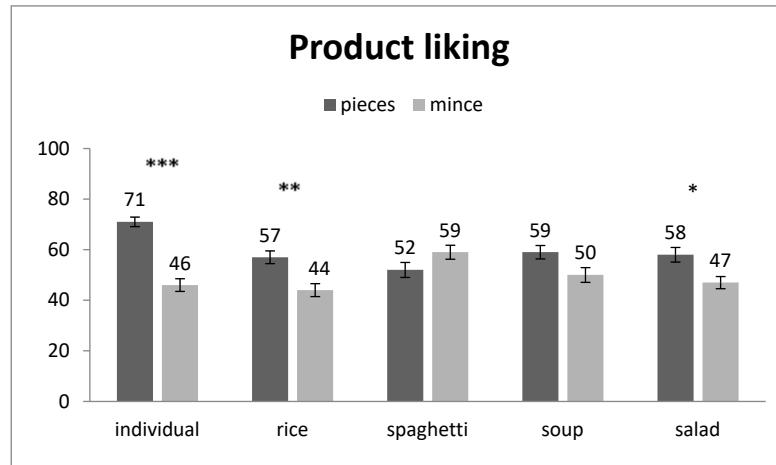
Figure 4.2 Mean product liking ratings (±SEM) of pieces and mince (of meat substitute A), evaluated when tasted individually and in four meals with meat substitutes. Differences between pieces and mince were compared. ***: p=0.000, **: p=0.002, *: p=0.033.
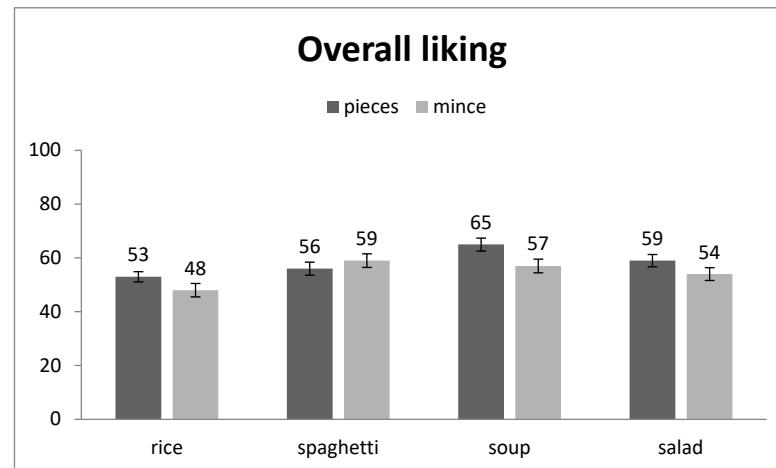
Figure 4.3 Mean overall liking ratings (±SEM) of four meals with meat substitutes (either pieces or mince of meat substitute A). Differences between pieces and mince were compared.
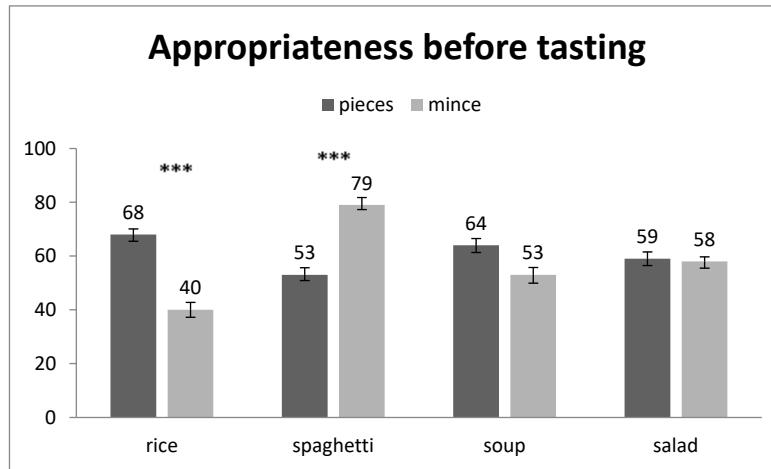
Figure 4.4   Mean appropriateness ratings (±SEM) of pieces and mince (of meat substitute A) in four meals with meat substitutes, evaluated before tasting the meal. Differences between pieces and mince were compared. ***: p=0.000
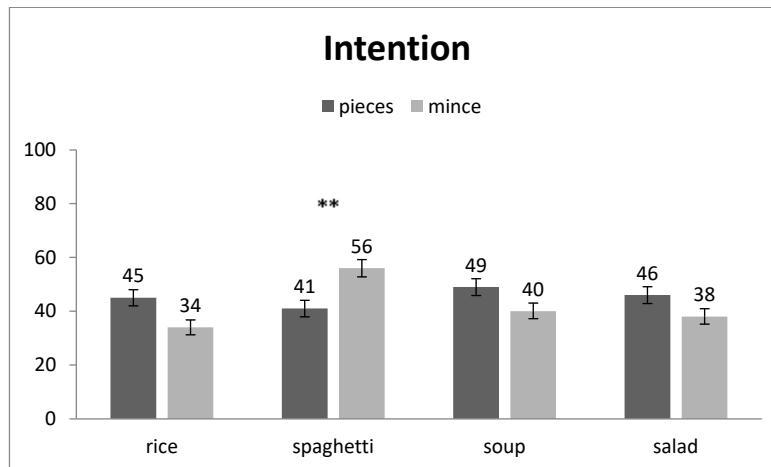
Figure 4.5   Mean ratings (±SEM) of 'intention to use' of four meals with either pieces or mince (of meat substitute A). Differences between pieces and mince were compared. **: p=0.002

Influence of flavor/texture on liking and appropriateness

Table 4.3 shows the significant differences between the mean ratings of the meat substitute pieces for every type of rice dish. There was a significant difference between the mean overall liking ratings of the five individual meat substitute pieces ($F(4,364)$ = 33.73, p = 0.000). A-pieces were liked best (71 ± 1.9), followed by E and B (60.8 ± 2.5 and 58.2 ± 2.5 respectively). C and D scored the lowest on overall liking (resp. 45.8 ± 2.8, and 39.0 ± 2.7).

Table 4.3　　　Mean overall liking ratings[*] for the individual meat substitutes, and the mean values[*] of 'product liking in the meal', overall liking, appropriateness (before and after tasting), and 'intention to use' for 15 combinations of meat substitutes and rice dishes. Values in the same row with no superscript or sharing a letter in the superscript are not significantly different (p> 0.05).

Outcome measure	Rice dish	Meat substitute				
		A	B	C	D	E
Overall liking	None[**]	71.1[a]	58.2[b]	45.9[c]	39.0[c]	60.8[b]
Product liking	Curry	57.9[a]	44.4[b]	53.1[ab]	43.7[b]	58.9[a]
	Satay	60.5[ab]	55.6[ab]	61.6[b]	47.7[a]	63.4[b]
	Sweet & sour	64.0[b]	57.4[ab]	53.8[ab]	46.4[a]	61.8[b]
Overall liking	Curry	55.1	48.9	54.0	47.9	54.1
	Satay	62.0[ab]	61.5[ab]	63.8[b]	54.1[a]	63.2[b]
	Sweet & sour	65.2[a]	60.4[ab]	60.8[ab]	52.9[b]	63.8[a]
Appropriateness	Curry	69.6[a]	58.0[b]	57.8[b]	66.4[ab]	58.8[b]
(before tasting)	Satay	64.9[ab]	60.4[ab]	60.7[ab]	68.0[a]	54.4[b]
	Sweet & sour	70.6	62.6	64.4	70.3	64.8
Appropriateness	Curry	62.6[a]	46.9[b]	58.4[ab]	51.0[bc]	59.0[ac]
(after tasting)	Satay	63.4	56.9	65.9	56.4	63.8
	Sweet & sour	66.5	57.2	62.1	57.0	64.5
Intention to use	Curry	47.0[a]	34.1[b]	43.1[ab]	36.5[ab]	41.9[ab]
	Satay	51.2	49.2	53.1	42.7	53.3
	Sweet & sour	57.7[a]	47.9[ab]	46.7[ab]	42.4[b]	55.7[ab]

[*] Standard error of the mean values were all between 1.9 and 3.3
[**] 'none' indicates the ratings for the individual meat substitutes (not eaten in a meal context)

Looking at the ratings of the meat substitute-rice dish combinations, we found significant differences for product liking ($F(9.30, 789.93)$ = 8.01, p = 0.000), overall liking of the dishes ($F(9.83, 835.71)$ = 8.14, p = 0.000), appropriateness before tasting ($F(6.23, 529.44)$ = 4.72, p = 0.000), appropriateness after tasting ($F(10.42, 885.92)$ = 5.36, p = 0.000), and intention to use ($F(9.98, 847.99)$= 6.91, p = 0.000). Meat substitute D scored lower than E in all rice dishes (curry, satay, and sweet& sour sauce), and lower than A-pieces and C in some of the dishes. The overall liking ratings of the curry rice dish were not significant for all meat substitutes. The satay rice dishes containing either C (63.8) or E (63.2) scored higher on overall liking than the satay dish with D (54.1), whereas for the overall liking of the rice dishes with sweet & sour sauce, A-pieces (65.2) and E (63.8) scored higher than D (52.9).

The mean ratings for appropriateness *before* tasting the dish show that A (62.6) scored higher than B, C, and E (58.0, 57.8, 58.8 resp.) in the curry dish. Meat substitute D (68.0) scored higher than E (54.4) in the satay dish. The sweet & sour rice dish showed no significant differences between the meat substitute pieces.

When appropriateness was rated *after* tasting the dish, meat substitutes A pieces (62.6) were more appropriate than meat substitutes B (46.9) and D (51.0) in the curry-rice dish. In the other rice dishes, all meat substitute pieces were equally appropriate.

Looking at intention-to-use, we found that the curry dish with A pieces scored significantly higher than the curry dish with B (47.0 and 34.1 resp.). The intention to use a dish with sweet & sour sauce was higher for A than for D (resp. 57.7 and 42.4). For the satay-dishes, we did not find differences for use-intention.

4.4   Discussion

This study was on meat substitutes that were eaten in a meal context. The focus of food scientists, technologists, and businesses has long been on individual foods instead of meals (Meiselman, 2000). One of the reasons for this is that the understanding of meals is complex and involves many research areas (including physiology, psychology, sociology, and culinary art). We agree with Meiselman, who pleats for meals to be incorporated in all working areas involving foods. This study aimed at obtaining insight into the influence of meal context and appropriateness on the acceptance of meat substitutes.

Influence of meal context on acceptance of meat substitutes

To answer the first research question, whether meal context influences the acceptance of meat substitutes, we compared the overall liking ratings of the individual meat substitutes with the ratings for 'product liking' (liking of the meat substitutes in the meal). As can be seen in Figure 4.2, A-pieces were better liked than A-mince when tasted separately and also when tasted in the rice dish and the meal salad. However, A-mince was rated slightly higher than A-pieces in the spaghetti dish, but this difference was not significant (p= 0.55). In the soup, both meat substitutes were equally liked. Although the participants liked A-pieces and mince differently in some dishes, these differences did not seem to matter for the overall liking of the dishes.

Looking at part 2 of the study (Table 4.3), it can be concluded that the differences in overall liking of the individual meat substitutes to a large extent disappeared in the overall liking ratings of the meals. This is what we expected because the other ingredients in the meal masked the flavors and texture of the meat substitutes. However, this effect was not the same for all meat substitutes. D, which scored the lowest when tasted separately, was also liked least in the rice dishes (although not all differences were significant). Apparently, the meal context can mask differences in flavor and texture of (meat substitute) ingredients only to a certain extent. C also scored low separately (and not significantly different from D), but the satay and sweet & sour dishes with C were liked just as well as with meat substitutes A, B, or

E. When tasted separately, meat substitute C did not seem to be a strong competitor of A-pieces on overall liking, but the rice dishes with meat substitutes A, B, C, or E were equally liked.

These results suggest that meal context does influence consumer liking of meat substitutes.

Influence of appropriateness on meal acceptance

We could ask ourselves why a food (ingredient) is liked in one dish and less liked or disliked in another. Both the harmony of foods that are consumed together and sensory contrast are important for a degree of complexity that is necessary for food combinations to be liked (Lawless, 2000). A scientific approach to the creation of new dishes is difficult, while restaurant chefs need a combination of artistic creativity, field experience, and systematic process (Vetter, 2009). Whether or not food combinations match well together depends on the appearance, the flavors and textures of the ingredients as well as their interactions (Lawless, 2000, Klosse, Riga, Cramwinckel & Saris, 2004, Vetter, 2009). We tried to get some insight into the influence of these aspects on the appropriateness and acceptance of meat substitutes. In part 1 of this study, we varied the appearance (shape) of the meat substitutes (pieces and mince), whereas in part 2, we chose meat substitutes that had a similar shape (pieces), but varied in flavor and texture. Regarding the shape of the meat substitutes, the appropriateness scores of the spaghetti dishes (rated *before* tasting the dishes) showed that mince was more appropriate than pieces in a spaghetti dish. The reason for this could be, that spaghetti with a tomato-based sauce with minced meat is quite a common dish in the Netherlands. *After* tasting the dishes, the overall liking scores for spaghetti with mince and spaghetti with pieces were not significantly different. When we looked at the use-intention scores, the spaghetti dish with minced-A scored higher than a spaghetti dish with A-pieces (p= 0.002). The same can be seen for the rice dishes with curry sauce. Rice with curry sauce and chicken pieces is a combination that most Dutch people know. This is probably why meat substitute pieces were significantly more appropriate than mince in a rice dish. Overall liking ratings for pieces and mince were not significantly different for the curry rice dishes, but the intention-to-use was borderline significantly higher for pieces than for mince (p= 0.054). This suggests that both liking and appropriateness are important for intention-to-use. To answer the second research question: when intention-to-use is taken as a measure for the acceptance of a meal, we can conclude that in this study, the appropriateness of a meat substitute in a meal seemed to influence meal acceptance.

We expected that participants would not have a strong opinion about the appropriateness of meat substitutes in the meal soup or meal salad, since these meal concepts have a less fixed format (i.e. they can be based on various, very different, recipes, with or without meat). As expected, the appropriateness ratings (*before* tasting) show no differences between pieces and mince for meal soup and meal salad.

The ratings of the soup (meat substitutes served in a fluid dish) and salad (meat substitutes served in a cold dish) were in the same range as the ratings for the rice and spaghetti dishes

(fig. 4.3 and 4.4). Thus, in this study, the way the meat substitutes are served (hot or cold, in a sauce, a soup, or a salad) did not seem to influence the appropriateness and liking ratings. In contrast with our findings, Puumalainen, Nykopp, and Tuorila (2002) found in their study that when a relatively unknown food (a cereal) was served in two dishes (as a cooked cereal and in a soup), this did affect the acceptability of the cereal.

Influence of flavor/texture on liking and appropriateness

With respect to the appropriateness or match of flavors and textures (part 2 of this study), we studied if the flavor and texture of meat substitutes influenced the appropriateness of the meat substitutes in a meal (third research question). Therefore, we served meat substitute pieces with similar appearance, but different taste and texture in three rice dishes (the same meal concept, but with three different sauces).

Regarding the appropriateness *before* tasting, we expected the appropriateness ratings of all meat substitute pieces to be the same since the shape of the meat substitutes was similar. However, A and D were found to be more appropriate than the other pieces. Expectations likely play a role in our results; from the appearance of the meals, participants could have expected a meal with meat or chicken instead of with meat substitutes. Since respondents were told that they would taste samples containing meat substitutes or meat/chicken, their expectations were based on this information and on the appearance of the samples. Meat substitutes A-pieces and D looked more like meat or chicken pieces than the other meat substitute pieces, and this can explain why they scored higher on the appropriateness (*before* tasting). A study on the effect of expectations on the acceptance of unfamiliar foods also concluded that the acceptance of an unfamiliar food was influenced by how it relates to familiar foods that are part of an individual's diet (Tuorila, Meiselman, Cardello, Lesher, 1998). Yeomans, Chambers, Blumenthal & Blake (2008) showed that disconfirmed expectations can lead to a strong contrast effect and rejection of the test food. In our study, meat substitute D was liked least of all meat substitute pieces (as rated *after* tasting), and this may also be due to disconfirmed expectations. The appearance of D generated expectations of a meat product, while the flavor/texture was very different from meat. Meat substitute A-pieces also looked more like chicken or meat than the other meat substitute products, but the flavor/texture of A was liked better than D.

Regarding the appropriateness or match of flavors, we did not find any differences between the meat substitutes in the appropriateness *after* tasting the dishes, except for the curry sauce, where the differences between A and B still existed after tasting and D scored also lower than A. As was concluded in Section 4.1, the overall liking scores of the individual meat substitutes and the meals show that the masking effect of the sauces was not the same for all meat substitutes. This suggests that the match of flavors and textures for some meat substitute-meal combinations is better than for others. Seasonings or sauces with familiar flavors have been shown to increase the liking and the willingness-to-taste unfamiliar foods (Stallberg-White & Pliner, 1999; Pliner & Stallberg-White, 2000; Prescott, *et al*, 2004). These familiar sauces may belong to culturally dependent 'flavor principles' (i.e. characteristic flavor

profiles that are familiar to the people in a certain group or culture) or to a foreign cuisine that has become familiar to a consumer (Rozin, 2000; Rozin & Tuorila, 1993). In our study, the sauces for the rice dishes were based on Asian cuisines and were well-known to Dutch consumers. We did not find an unambiguous effect of these familiar sauces on the appropriateness (*after* tasting) or product liking of the meat substitutes. Meat substitute A-pieces was liked less in all three rice dishes than when tasted separately, whereas meat substitutes C and D were liked more in the rice dishes than separately.

Different outcome measures have been used in this research. Overall liking is a hedonic or affective measure that is being used in many types of consumer research, whereas appropriateness is more a cognitive judgment (Schutz, 1994), and 'the term 'appropriateness' implies some more normative aspect of how well a food 'fits' in the contextual situation in which it is eaten' (Cardello & Schutz, 1996; Cardello, Schutz, Snow & Lesher, 2000). We included intention-to-use as a measure that was more closely related to actual behavior since consumer behavior and food choice is what we are actually interested in. When we combined the data of part 1 and part 2, we found a Pearson's correlation coefficient of 0.66 between overall liking of the meal and appropriateness (*after* tasting). Apparently, meals with meat substitutes that are liked are not always considered to be appropriate combinations, and appropriate combinations can be disliked. The high correlation of 0.81 between product liking (liking of the meat substitute in the meal) and appropriateness (*after* tasting) indicates that meat substitutes that are liked tend to score high on appropriateness in the meal. This is similar to the conclusion of Cardello and Schutz (1996) that products of higher acceptance were found to be more appropriate in any situation than products of lower acceptance. They found a correlation of 0.83 between the overall liking of a wide range of food items and the mean rating from an item-by-use appropriateness questionnaire (with 10 use situations). Cardello, Schutz, Snow & Lesher (2000) found much lower correlations (-0.03 to 0.29 for appropriateness *before* tasting, and -0.33 to 0.43 for appropriateness *after* tasting) in their experiments with an appropriate and an inappropriate food for lunch, and with a dish eaten in an appropriate situation and in an inappropriate situation. They stated that appropriateness ratings 'tap idealized beliefs about the fitness of the food for a specific situation, and are less dependent on the sensory or hedonic quality of the food item'. We found a moderate correlation of 0.40 between appropriateness (*before* tasting) and product liking (and also 0.40 between appropriateness (*before* tasting) and overall liking of the meal), suggesting that the appropriateness in a meal context, as researched in our study, seems to contain both normative and hedonic aspects.

The overall liking of the individual meat substitutes ranged from 39.0 (meat substitute D) to 71.1 (meat substitute A), and the product liking of the meat substitutes in the rice dishes from 43.7 (meat substitute D in curry rice) to 64.0 (meat substitute A-pieces in sweet & sour rice). These ratings seem quite low on a 0-100 scale. To get an idea of the acceptance of the meat substitute pieces in this study in comparison to chicken, we served individual chicken pieces and rice dishes with chicken pieces. This was done in a separate and later part of the study using the same participants (data not shown here). When meat substitute pieces were

compared to chicken pieces, we found that individual chicken pieces (76.7) scored significantly higher than meat substitutes B, C, D, and E (p= 0.000), but not differently from A pieces (p= 0.273). However, the product liking of the chicken pieces in the rice dishes was significantly higher than <u>all</u> meat substitute pieces in the rice dishes. This underlines the importance of testing foods in the (meal) context they will be consumed in.

Individual meat substitutes were also rated on 'similarity to meat'. The results of focus group discussions performed earlier suggested that meat substitutes should resemble meat in their appearance, flavor, and texture, according to some consumers (Elzerman, 2006; Elzerman, 2013). In the study presented here, we found that meat substitute A pieces scored much higher on 'similarity to meat' than meat substitute B (69 and 29 resp.). However, *meals* with either meat substitute A- pieces or B did not score differently on overall liking, product liking, or appropriateness after tasting (except for the rice with curry sauce). Therefore, 'similarity to meat' does not seem to be a prerequisite for the acceptance of meat substitutes in a meal context. An in-home use test following this study, compared Quorn™ pieces (marked as A-pieces in our study), tofu strips (meat substitute B), and chicken pieces on their acceptance after repeated consumption for 10 weeks (2 times/week) (Hoek, *et al*, 2013). In line with our findings, 'similarity to meat' did not influence long-term acceptance of meat substitutes either.

The research on meal context and appropriateness presented here was executed within the framework of a multidisciplinary research program on meat substitutes (PROFETAS). To be able to identify consumers' preferences regarding meat substitutes, we worked with commercially available products. These products differed in ingredients, appearance, flavor, and texture. More research with products that differ only in one modality is needed to elucidate further the role of meal context and appropriateness in food acceptance.

4.5 Conclusions and implications

We can conclude that in this study:

- Meal context influenced the acceptance of meat substitutes
- Appropriateness of meat substitutes in a meal (as rated *before* tasting the meal) influenced the acceptance of the meal.
- *Match of flavors and textures*: The masking effect of the meals was not the same for all meat substitutes. This difference between the meat substitutes was reflected in the overall liking of the meal, and not in the appropriateness (*after* tasting).

What do our results imply for the development of meat substitutes as alternatives to meat? For meat substitutes to be accepted by non-vegetarian consumers, they should fit in the meal, and for that, the shape and appearance seem important. The ingredients and flavor and texture of the meat substitutes did not seem to be crucial for the acceptance of the meals with meat substitutes. To get more insight into the acceptance of meat substitutes, we need sensory research including descriptive analysis.

For food product development in general and meat substitutes in particular, our results suggest that more emphasis is needed on consumer evaluation of meal combinations instead of on the sensory properties of the individual product.

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CHAPTER   5

Situational appropriateness of meat products, meat substitutes and meat alternatives as perceived by Dutch consumers

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Abstract

The development of meat substitutes could contribute to a more sustainable food production system. Although the consumption of meat substitutes in the Netherlands has grown over the last decades, meat consumption stayed roughly the same. This led to the question of whether meat substitutes fit in the same usage situations as meat products do. Perceived situational appropriateness of meat, meat substitutes, and other meat alternatives in different usage situations was studied using an item-by-use appropriateness survey. Products were presented via photographs and for each combination of product and situation, the appropriateness was rated on a 7-point scale. Personal information included the consumption of meat and meat substitutes and Food Neophobia. An exploratory survey was conducted in 2004 and an online survey in 2019.

Overall, meat products were perceived as more appropriate than their vegetarian equivalents (e.g. hamburger vs. vegetarian hamburger) in almost all situations. Meat alternatives (chickpeas, nuts) scored generally higher than meat substitutes on situational appropriateness. Age and gender affected appropriateness ratings: women and younger respondents gave higher ratings to meat substitutes and meat alternatives. Food Neophobia showed a small effect. Meat substitute consumption frequency was a predictor of overall appropriateness in 2019, where it was not in 2004. Results underpin that situational appropriateness and consumer characteristics should be taken into account in new product development of meat substitutes. Furthermore, meat alternatives like chickpeas and nuts could also contribute to the reduction of meat consumption.

5.1   Introduction

Over the last decades, it has become clear that worldwide food consumption and food production systems have a substantial impact on the environment. The livestock sector seems the most resource-intensive and polluting sector of the food industry since it has a big impact on greenhouse-gas emissions, use of freshwater, and land (Global Agriculture, 2020.; Godfray, 2019; Hallström, Carlsson-Kanyama, & Börjesson, 2015; Vinnari & Tapio, 2009). To specify, the production of beef in the livestock sector is the most burdensome practice as it uses about 70 % of the world's agricultural land (van Zanten, *et al*, 2018). Moreover, due to the still-growing world population, it is expected that global meat production will keep on growing for the next decades (Aiking, 2011; OECD-FAO, 2019). So, due to this environmental pressure and with the still-growing meat production and consumption in mind, a shift in our dietary behavior from an animal-based diet toward a more plant-based diet is an urgent need to be environmentally more sustainable *et al*, 2011). Numerous alternative protein foods that can act as meat substitutes have been launched on the market and became widely available since the middle of the 20th century (Godfray, 2019; Shurtleff & Aoyagi, 2013). However, the adoption of meat substitutes by consumers is slow and many products are not meeting consumer demands since the texture and taste of those products do not always resemble the texture and taste of meat, as shown by own results (Elzerman, Hoek, van Boekel and Luning, 2011; Elzerman, van Boekel and Luning, 2013, Elzerman, Hoek, van Boekel and Luning, 2015) and others (e.g. Hoek, van Boekel, Voordouw and Luning, 2011; Hartmann & Siegrist, 2017).

Meat products are eaten as versatile components of the meal in different use situations (Elzerman *et al*, 2013). Sustainable meat alternatives should therefore not only be appreciated by consumers but also fit in their daily lives. The meat substitutes should be appropriate in the use situations, the context, in which normally meat products would be eaten. The context in which food products are eaten influences product acceptance (e.g. King, Meiselman, Hottenstein, Work and Cronk (2007); Elzerman *et al* (2011); Hersleth, Monteleone, Segtnan and Naes (2015); Jaeger and Porcherot (2017). Traditionally, both in the food industry as well as in food science, consumer testing often still focuses on the product alone and neglects the context. Reasons for this are that involving the context in consumer testing is time-consuming, costly and logistically more complex (Tuorila & Lahteenmaki, 1992, Meiselman, 2013). However, recent studies underlined the importance of context in consumer research (Piqueras-Fiszman and Jaeger, 2015; Jaeger, Roigard, Le Blond, Duncan, Hedderley, Giacalone, 2019). Context includes the social or situational context (i.e. where, when, how, and with whom the food is eaten) or the meal context (i.e. which other foods accompany the food product when it is eaten) (Meiselman, 2008). Context also plays a role in the acceptance of unfamiliar and new foods. When it is difficult for the consumer to know what product characteristics to expect, contextual factors might be more important than when a familiar food is eaten. To illustrate, serving a familiar sauce with a novel food enhanced the willingness to try and the acceptance of the food by adults and children (Pliner and Stallberg-White, 2000). The acceptance of meat substitutes was also influenced by the meal context they were served

in (Elzerman *et al*, 2011). Situational and social context can influence consumer acceptance of novel foods as well. Social interaction has been shown to influence novel food consumption (López-Espinoza, de la Torre-Ibarra, Aguilera, Galindo, Martínez, and Gonzalez, 2007). Moreover, in a qualitative study on meat substitutes, consumers reported considering their family members' opinions when shopping for food (Elzerman *et al*, 2013). An exploratory survey in 2004 on the appropriateness of meat substitutes indicated that also the situational context affected perceived appropriateness (unpublished data).

In the last fifteen years, however, meat substitute consumption has grown at a rate of 4-6%, up to 10% in 2019. Despite this increased popularity, the market share of meat substitutes is still low: a niche market with less than 2% of the meat market (ABN AMRO, 2019). An average Dutch household only spent 13 euros on meat substitutes, whereas 224 euros was spent on meat (Menkveld, 2019). Dutch meat consumption (as gross carcass weight) was stable at around 77 kg per person per year between 2005 and 2018 (Dagevos, Verhoog, van Horne and Hoste, 2019). In the meantime, more consumers were willing to decrease their meat consumption for environmental or health reasons (Consumentenbond, 2016; Sanchez-Sabate and Sabaté, 2019). The increased popularity of meat substitutes together with the increased motivation of consumers to mitigate their meat consumption led to the question of whether meat substitutes now fit better in the usage situations of Dutch consumers than fifteen years ago. The main objective was to explore the appropriateness of meat products, meat substitutes, and meat alternatives in different usage situations. The term meat products was used for unprocessed or processed meat from animals; meat substitutes were defined as products that were developed to be eaten instead of meat, and meat alternatives are other products that are often eaten as a protein source in vegetarian meals, such as pulses and nuts. The underlying research questions were:

1) What is the perceived appropriateness of meat products, meat substitutes, and meat alternatives across different usage situations?
2) Is there a difference in the perceived appropriateness of meat products, meat substitutes, and meat alternatives between various consumer groups based on personal characteristics?

The results of the 2019-survey were compared to the findings of the exploratory 2004-study to gain insight into changes in the appropriateness of meat and meat substitutes over fifteen years.

5.2 Materials and methods

Meat products, meat substitutes and meat alternatives

Five meat products and their vegetarian equivalents (meat substitutes) were used: minced beef and vegetarian mince, chicken pieces and vegetarian stir-fry pieces, hamburger and vegetarian hamburger, smoked sausage and vegetarian sausage, steak and vegetarian steak. Two meat alternatives that do not resemble any meat product (chickpeas and nuts) were

added to see if these products were different in situational appropriateness compared to the meat substitutes. The products were presented to the respondents as a photograph of the product on a plate (without other food items) together with the food name.

Surveys

An exploratory survey was developed and conducted in 2004, according to the item-by-use appropriateness method by Schutz (1994) and the situations that were used were based on the information that was generated during focus group discussions on meat substitutes (published in Elzerman *et al*, 2013). The 2019-survey was based on the 2004-survey, with some adaptations: a paper questionnaire was used in 2004, whereas in 2019 the online survey software QualtricsXM® was used to facilitate the recruitment of respondents and completion of the questionnaire. Furthermore, a few products were different and the number of situations that needed to be rated was reduced in 2019 because some situations had shown very similar appropriateness ratings in the 2004 survey.

The 2019-survey consisted of 3 parts, in the first part an introduction was given, and demographic questions were asked. The second part included questions on the consumption frequencies of meat and meat substitutes and on Food Neophobia (i.e. the tendency to avoid new foods) (Pliner & Hobden, 1992; Hoek, Elzerman, Hagemans, Kok, Luning, de Graaf, 2013). Respondents were also asked to indicate whether they considered themselves to be either a 'meat eater', 'flexitarian', 'vegetarian', or 'vegan'. Flexitarian is a well-known, but broad term in the Netherlands, and the definition 'I refrain from eating meat at least one day a week' was used (Verain, 2020). The third part measured the item-by-use appropriateness of various meat products, meat substitutes, and meat alternatives in different situational contexts. All situational contexts focused on the domestic domain (i.e. consumption at home).

The usage situations were phrased as follows:

Usage situation:	*Abbreviated in figures as:*
'when I eat with my family'	Family
'when I want to prepare a special meal'	Special
'when I eat with vegetarians'	Vegetarians
'when I eat with friends'	Friends
'when I eat alone'	Alone
'when I cook for children'	Children
'to add flavor to the meal'	Flavoring
'when I have little time to cook'	little time
'when I want to eat a healthy meal'	Healthy

A photograph of a food product (meat products, - substitute, or – alternative) was shown together with the food name and the question that accompanied each photograph was: how appropriate do you find this food item as part of the hot meal in the following situations? The respondents indicated their perceived appropriateness score on a 7-point scale, anchored with 1= never appropriate and 7=

always appropriate. There was no reference to brand names or ingredients of the food items. The food items were all well known in the Netherlands, except for some of the meat substitutes.

A progress bar was added to stimulate respondents to finish the survey. An example of a page in the survey can be found in Part 1 of the Supplementary Material of the paper.

A pretest was conducted among eleven respondents of different ages and educational levels to check for unclarities and duration of the survey. Based on the feedback, some minor corrections were made. The survey was approved by the Social Sciences Ethics Committee of Wageningen University and Research.

Respondent recruitment

In 2019, a non-random convenience sample was used to collect data from respondents with various backgrounds. Recruitment took place via social media (LinkedIn, Facebook, Instagram) of the researchers and via flyers and other promotional materials in public buildings and shops. The survey and all information were in Dutch and the information in the flyers was aimed clearly to attract respondents who had experience with preparing a meal with meat and/ or meat substitutes. Criteria that had to be met to be included in the study were: a full completion of the survey and a minimum completion time of 260 seconds for meat-eaters, or 200 seconds for vegetarians or vegans, since they were not asked to fill in the questions about meat products. A total of 388 respondents completed the whole survey and met the inclusion criteria.

The 79 Dutch consumers that completed the exploratory 2004-survey were recruited from a panel that had taken part in a Central Location Test (CLT) on meals with meat substitutes (Elzerman *et al*, 2011). These respondents were all non-vegetarians. Table 5.1 shows the demographics and consumption data of the respondents of the two surveys.

Data analysis

Data analysis was performed using IBM SPSS Statistics® Version 26. Mean appropriateness ratings and standard error of the mean (SEM) were calculated for every product in a specific situation. Meat products were compared to their vegetarian equivalents to get insight into how their item-by-use appropriateness profiles differed.

Repeated measures analysis of variance (ANOVA) was used to identify significant differences between the mean item-by-use appropriateness ratings. For the difference between consumer groups, repeated-measures ANOVA was performed with the consumer group (e.g. meat substitute consumption or Food Neophobia) as a factor. The Greenhouse-Geisser correction was applied if the assumption of sphericity was violated (as tested using Mauchly's test of sphericity). Contrasts were calculated using a Sidak correction and effects were reported as significant at $p < 0.05$. Spearman's Rho coefficient was calculated to see whether there was a significant correlation between appropriateness ratings and a consumer characteristic (meat substitute consumption, Food Neophobia Score, or age). One-way ANOVA and independent t-tests were used to compare the means of gender or of the different years (2004 and 2019). A correction for multiple comparisons was applied. Also, an overall appropriateness score (i.e. mean appropriateness rating for all meat substitutes together and based on all situations for every respondent) was calculated, and simple linear regression was performed to predict overall appropriateness scores based on meat substitute consumption frequency. For this, we used the seven categories of meat substitutes consumption frequency (displayed in Table 5.1).

Table 5.1   Demographic and consumption data of the respondents in the two surveys[1]

		2004-Survey n=79	2019-Survey n=388
Gender			
Male		22.8	21.6
Female		77.2	78.1
Other[3]			0.3
Age group (years)			
17-24		48.1	37.7
25-34		10.1	13.4
35-44		15.2	7.7
45-54		8.9	22.4
55-64		16.4	12.4
65-74		1.3	5.2
75-84		0	1.3
Lifestyle ('I describe myself as a…')[3]			
Meat eater			27.8
Flexitarian (I refrain from eating meat at least 1 day/week)			52.5
Vegetarian (I never eat meat)			14.3
Vegan (I never eat animal-derived foods)			6.2
Meat consumption (with a hot meal)			
Never[2]		-	19.3
Less than once a week		2.5	5.4
1-2 times a week		12.7	16.0
3-4 times a week		34.2	31.4
5 times a week or more		50.6	27.8
Meat substitute consumption (with a hot meal)	Group		
Never	Non-user	16.5	13.7
Tried only a few times	Light user	20.3	15.5
Less than once a month	Light user	17.7	7.0
1-3 times a month	Medium user	20.3	21.6
1-2 times a week	Medium user	20.3	27.3
3-4 times a week	Heavy user	5.1	11.6
5 times a week or more[3]	Heavy user	-	3.4
Food Neophobia Score (range 10-70)			
Low (10-30)		16.9	63.7
Moderate (31-50)		83.1	34.8
High (51-70)		0	1.5

[1]Data are presented as percentages. [2]Only non-vegetarian respondents participated in the 2004 survey. [3]Spaces that were left open were questions/answers that were not part of the 2004 survey.

5.3   Results

Item-by-use appropriateness of meat products, meat substitutes and meat alternatives

The mean appropriateness ratings per usage situation for every product were calculated and plotted to see the differences in appropriateness patterns between products (Figure 5.1). Spider plots A through E show how meat products were rated compared to their vegetarian equivalents, whereas F compared meat alternatives (chickpeas, nuts) to the highest scoring meat substitute (stir fry pieces). When looking at specific situations, meat products did not score higher than meat substitutes in *all* situations. For the situation 'when I want to eat a healthy meal', the vegetarian hamburger was rated significantly higher than the normal hamburger. However, the smoked sausage also rated low on this situation, but so did the vegetarian smoked sausage. Also, in the situation 'when I want to prepare a special meal', hamburger and smoked sausage were not rated higher than their vegetarian equivalents. These products were not considered very special, according to their appropriateness scores. Contrarily, the steak was highly appropriate when a special meal was prepared and for adding flavor to the meal and when eating with friends. The vegetarian steak was given much lower ratings in all these situations. The meat alternatives (chickpeas and nuts) generally scored higher than the meat substitutes. Nuts were perceived as more appropriate than stir fry pieces in all situations, except for 'when I cook for children' and 'for vegetarians', where stir fry pieces were found equally appropriate. Chickpeas followed a similar pattern as stir fry pieces, but with higher appropriateness for 'when I want to eat a healthy meal' and lower appropriateness for 'when I cook for children'.
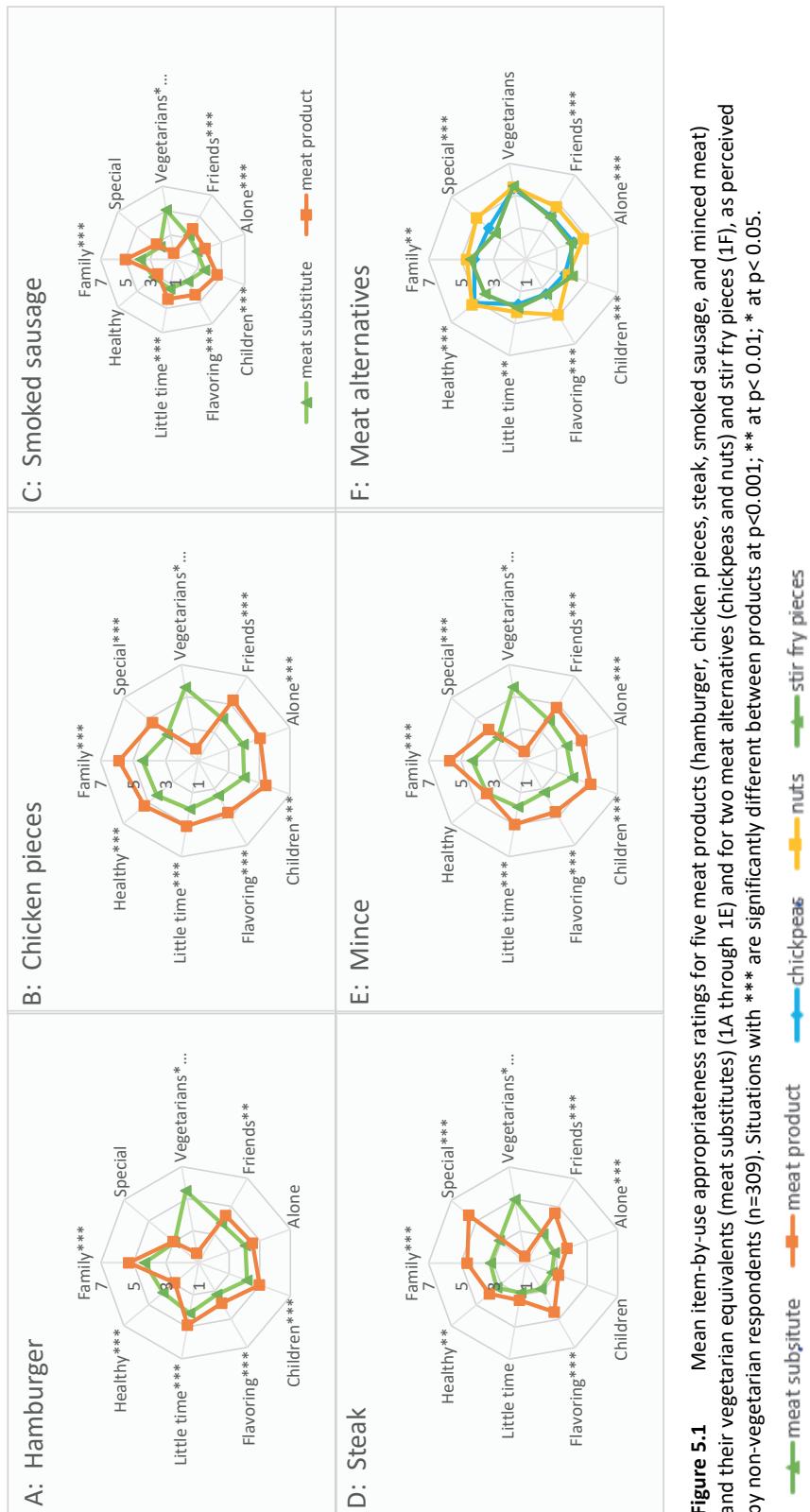
Figure 5.1 Mean item-by-use appropriateness ratings for five meat products (hamburger, chicken pieces, steak, smoked sausage, and minced meat) and their vegetarian equivalents (meat substitutes) (1A through 1E) and for two meat alternatives (chickpeas and nuts) and stir fry pieces (1F), as perceived by non-vegetarian respondents (n=309). Situations with *** are significantly different between products at p<0.001; ** at p< 0.01; * at p< 0.05.

Importance of personal characteristics

The influence of gender, age, and Food neophobia
Men tended to rate the appropriateness of meat products slightly higher than women. Out of the 45 possible combinations of meat products and situations, 22 were rated as more appropriate by men (49%). The other situations showed no significant difference between men and women. Appropriateness of meat substitutes, however, was rated lower by men in nine situations (20%), but higher in two situations (4%). Out of all nine situations, chickpeas were rated lower by men in four cases (44%) and nuts in seven cases (78%) (see Part 3 of the Supplementary Material of the paper).

Also, the age of the respondents seemed to influence the appropriateness scores. About 51% of the appropriateness ratings for meat substitutes was negatively correlated with age, whereas 53% of the ratings for meat products was positively correlated with age. The data indicated that older respondents tended to give lower appropriateness ratings to meat substitutes and higher ratings to meat products. This effect of age was only weak (- 0.3 $<r_s<$ -0.1 for meat substitutes and 0.1 $<r_s<$ 0.3 for meat products, p< 0.05). Surprisingly, a medium *negative* effect was found for both hamburger and vegetarian hamburger in the situation 'when I eat with friends', indicating that older respondents found a hamburger or a vegetarian hamburger in this situation less appropriate than younger respondents (r_s= - 0.38, p<0.001 and r_s= - 0.34, p< 0.001 respectively, see Part 4 of the Supplementary Material of the paper).

The tendency to avoid new foods, measured by the Food Neophobia Score (FNS) showed negative, but weak correlations in some situations for meat substitutes and meat alternatives (- 0.3 $<r_s<$ -0.1, p < 0.05), whereas positive, weak correlations were found for meat products (0.1 $<r_s<$ 0.3, p < 0.05). This indicates that more neophobic respondents gave slightly higher ratings to meat products and slightly lower ratings to the appropriateness of meat substitutes and meat alternatives in some situations (Part 5 of the Supplementary Material of the paper)

The influence of usage frequency of meat and meat substitutes
To further explore how the consumption of meat substitutes relates to the situational appropriateness of these products, we calculated the mean appropriateness ratings for different meat substitute consumption groups (non-users, light-users, medium-users and heavy-users). Figure 5.2 depicts the item-by-use appropriateness ratings for each meat substitute for these consumption groups. A clear pattern of higher appropriateness ratings for the more frequent meat-substitute users was found for all meat substitutes. Striking is that the appropriateness pattern for every product was comparable for each user group. The more often a respondent consumes meat substitutes, the *higher* a meat substitute was rated on item-by-use appropriateness. From the meat alternatives, chickpeas showed a similar pattern, but nuts showed only a low effect on meat substitute consumption frequency. Nuts received quite high

ratings from the light, medium, and heavy users, and only the non-user group rated all situations significantly lower than the other groups (see Part 6A of the Supplementary Material of the paper).

This relation between meat substitute consumption frequency and appropriateness ratings was confirmed by Spearman's Rho correlation coefficients, which showed mostly medium ($r_s > 0.3$; $p < 0.01$) and high ($r_s > 0.5$; $p < 0.01$) correlations for combinations of meat substitute and situation (see Part 6B of the Supplementary Material of the paper). This means that the more often respondents consume meat substitutes, the higher they tend to rate the appropriateness of a meat substitute in a usage situation. When only non-vegetarian respondents (i.e. the respondents who describe themselves as a 'meat eater' or a 'flexitarian') are considered, the same pattern, but with somewhat lower correlation coefficients, was found (Part 6C of the Supplementary Material of the paper).

Significant negative, but weak correlations ($r_s < -0.1$) were found between meat substitute usage frequency and most meat products in a particular usage situation, indicating that the more often meat substitutes are eaten, the *lower* the appropriateness ratings of meat products were (all p-values < 0.05) (see Part 6B of the Supplementary Material of the paper).

A: Vegetarian stir-fry pieces

B: Vegetarian smoked sausage

C: Vegetarian steak

D: Vegetarian mince

E: Vegetarian hamburger
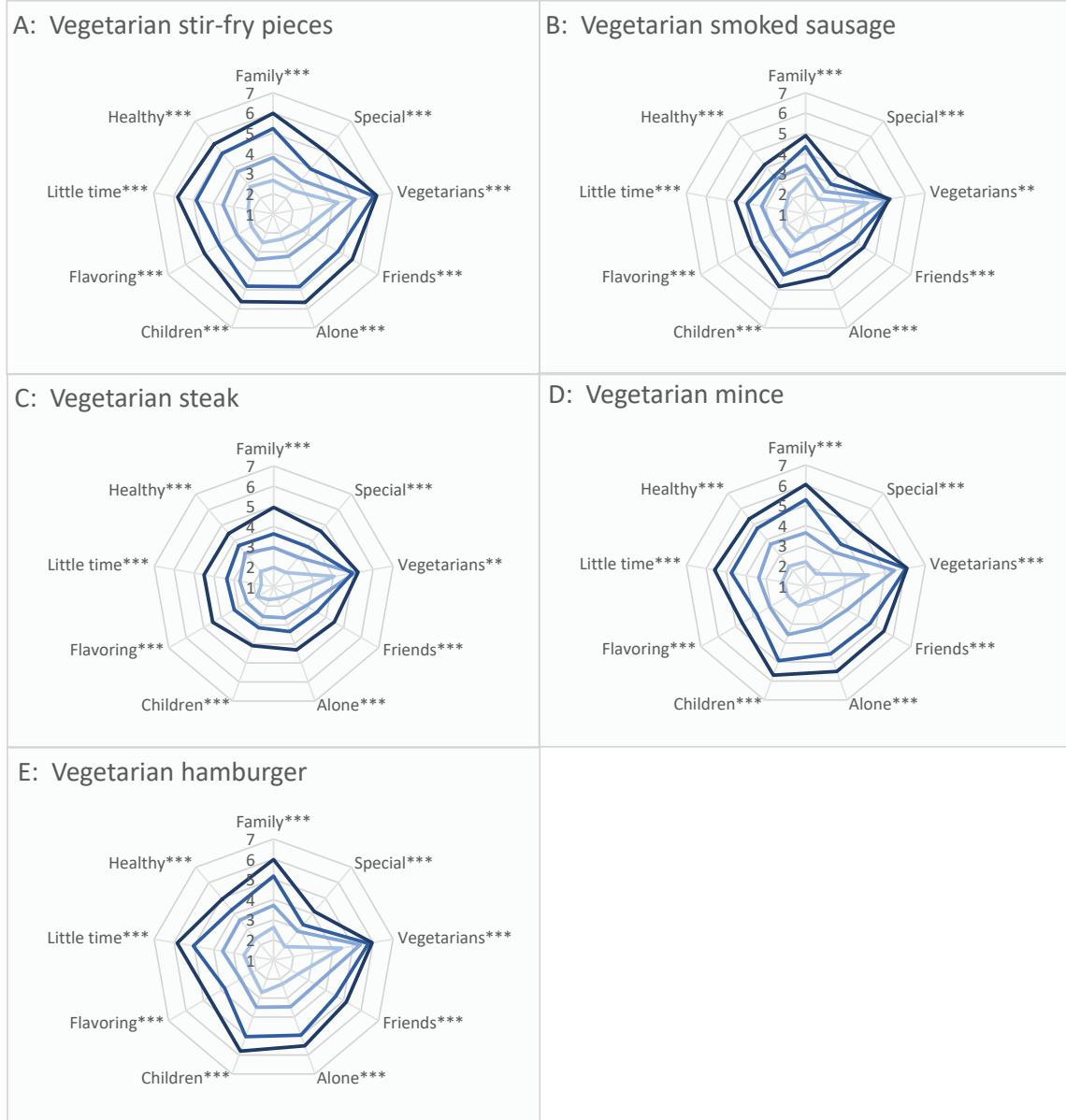
Non-user — Light-user — Medium-user — Heavy-user

Figure 5.2   Mean item-by-use appropriateness scores of the meat substitutes, as rated by non-, light-, medium- and heavy users of meat substitutes. 2019-Survey, all respondents included (N=388). Situations with *** are significantly different between consumption groups at $p<0.001$; ** at $p< 0.01$; * at $p< 0.05$.

Differences between the 2019- and 2004-surveys

To compare the current study with the exploratory study of 2004, we analyzed the differences in appropriateness ratings. Table 5.2 shows the significant differences between the mean appropriateness ratings of the meat products, meat substitutes, and meat alternatives for the nine usage situations between the years 2004 and 2019. Only the non-vegetarian respondents were included from the 2019-survey because the 2004-survey was only conducted among non-vegetarian consumers. Overall, the mean appropriateness ratings of meat products, meat substitutes and meat alternatives were similar between the 2004- and the 2019-surveys. Regarding the meat substitutes, only a few significant differences were found, and in those cases, the mean appropriateness rating for the 2019-survey was significantly *lower* than the rating in the 2004-survey. For the meat products, both a few positive and negative differences were found between 2019 and 2004.

Looking at the consumption of meat substitutes in both years, 48.8% of the meat-eating respondents in 2019 were medium users of meat substitutes (compared to 40.6% in 2004) and 7.4 % were heavy users (compared to 5.1 % in 2004). This higher usage frequency was not reflected in the results. Besides, the meat consumption frequency of the non-vegetarian respondents in the 2019-survey was lower than in the 2004-survey: 35.0% in 2019 ate meat with a hot meal at least 5 days a week (50.6% in 2004) and 39.5% on 3-4 days a week (34.2% in 2004), 19.4% ate meat on 1-2 days a week (this was 12.7% in 2004).

To get more insight into the similar appropriateness ratings in 2004 and 2019, we looked at how meat substitute consumption frequency could have influenced the appropriateness ratings in those years. For this, we calculated for every respondent an overall mean appropriateness rating for all meat substitutes together and based on all situations. A simple linear regression was calculated to predict overall appropriateness scores for meat substitutes based on meat substitute consumption frequency. We did not find a significant regression equation for the 2004-survey, indicating that meat substitute consumption frequency could not explain the appropriateness ratings in the 2004-survey. To be able to compare the two surveys, only the non-vegetarian respondents from the 2019-survey were used in the calculation, and a significant regression equation was found $F_{(1, 307)} = 110.683$, $p < 0.001$ with an R^2 of 0.265. This indicates that meat substitute consumption frequency accounted for 26.5% of the variation in overall appropriateness ratings of meat substitutes in the 2019-survey.

Table 5.2 Comparison of mean appropriateness ratings for five meat products, four meat substitutes, and one meat alternative[1,2,3].

Usage Situation	Year	Hamburger		Chicken pieces		Sausage		Mince		Steak	Nuts
		Meat	Meat substitute	Meat	Meat substitute	Meat	Meat substitute	Meat	Meat substitute	Meat	
Family	2004	4.8	4.1	5.9	4.7	5.3	4.0	6.0	4.4	4.9	5.0
	2019	5.3	4.3	5.9	4.4	5.0	3.8	5.7	4.3	4.6	4.7
Special	2004	2.5	2.6	4.6	3.4	3.1	2.6	4.0	2.9	*6.1*	5.3
	2019	3.0	2.9	4.7	3.5	2.9	2.6	4.0	3.2	*5.6*	5.0
Vegetarians	2004	*1.2*	*5.8*	*1.2*	*6.2*	*1.2*	*5.7*	*1.1*	*5.9*	*1.2*	*6.3*
	2019	*1.6*	*5.5*	*1.8*	*5.6*	*1.5*	*5.1*	*1.6*	*5.6*	*1.4*	*5.5*
Friends	2004	*3.5*	3.1	5.3	3.9	4.2	2.9	5.1	3.6	4.6	5.1
	2019	*4.4*	3.8	5.3	4.0	3.9	3.2	4.8	3.9	4.6	4.7
Alone	2004	4.2	4.0	5.1	4.4	3.6	3.2	4.8	3.3	4.1	4.4
	2019	4.5	4.1	5.1	3.9	3.6	2.9	4.6	3.7	3.7	4.7
Children	2004	5.5	4.7	5.5	4.1	*5.4*	*4.3*	5.5	4.1	3.7	3.5
	2019	5.0	4.2	5.4	4.0	*4.6*	*3.5*	5.2	4.0	3.1	3.8
Flavoring	2004	3.8	3.4	4.6	3.3	*5.0*	3.8	*5.3*	3.2	4.9	5.0
	2019	3.9	3.3	4.7	3.5	*4.3*	3.1	*4.6*	3.3	4.5	4.9
Little time	2004	5.1	4.6	4.9	4.5	4.7	*4.3*	5.1	4.1	*4.2*	4.1
	2019	4.9	4.2	5.1	4.0	4.2	*3.4*	5.0	3.9	*3.3*	4.3
Healthy	2004	2.5	3.9	4.9	5.0	2.9	3.6	4.0	4.2	4.6	5.0
	2019	2.9	3.9	5.3	4.3	2.8	3.2	4.1	4.1	3.9	5.3

[1] The vegetarian steak was not yet available, and chickpeas were not tested in the 2004-survey and are therefore not part of this comparison

[2] SEM was between 0.08 and 0.23 for 2004 and between 0.06 and 0.12 for 2019

[3] Differences between the years 2004 (N = 79) and 2019 (N = 309) are written in italic and bold ($p<0.05$); only non-vegetarian respondents were included.

5.4   Discussion

In the survey presented here, we investigated the perceived situational appropriateness of meat substitutes, meat alternatives, and meat products to discover how these products relate to each other in terms of suitability for usage in daily life. This information could be used in the first steps of new product development and marketing strategies for meat substitutes.

Our findings showed that the situational appropriateness was different for the meat products, meat substitutes, and meat alternatives that were assessed. The appropriateness scores for most situations were higher for all meat products compared to their vegetarian equivalents (Figure 5.1), meaning that overall, meat substitutes were not considered as appropriate as meat products in the usage situations we tested. The versatility of meat products seemed higher than of meat substitutes. However, in some situations, the meat substitute was perceived as more appropriate than the original meat product, e.g. for a 'healthy meal', in the survey of 2019 as well as 2004. This confirms that healthiness is one of the drivers of meat substitution. This was also found in a survey by Hoek et al (2011) that showed that mainly consumers who consumed meat substitutes at least once a week perceived meat substitutes as healthier than meat. That study also showed that meat was more suitable for special occasions, something that can be concluded from our study as well, where, for example, the steak was highly appropriate when a special meal was prepared and for adding flavor to the meal and when eating with friends. The vegetarian steak was given much lower ratings to all these situations. An explanation could be that consumers categorize meat substitutes with 'processed' products and a steak with 'unprocessed' meat (Hoek et al, 2011). Therefore, the expectations of steak and vegetarian steak could be essentially different. An additional explanation could be that the sensory expectations of the relatively new vegetarian steak were based on sensory experiences with other meat substitutes and these could simply not meet the highly appreciated sensory standards of steak.

Another interesting outcome of the study was that the meat alternatives (chickpeas and nuts) generally scored higher than the meat substitutes. Especially nuts are considered quite appropriate in all situations. From a sustainability perspective, this is a positive outcome, as pulses and nuts only need minimal processing. Contrarily, the production of most meat substitutes still requires energy-intensive processing that reduces potential sustainability gains (van der Weele, Feindt, van der Goot, van Mierlo, van Boekel, 2019).

When looking at the personal characteristics of the respondents, the personality trait food neophobia showed only a weak effect on appropriateness ratings in the current research (see Part 5 of the Supplementary Material of the paper). A reason for this can be that the majority of the consumers included in this research were relatively food neophilic, which means that they generally liked to try new foods. Other studies concluded that food neophobia was sometimes, but not always linked to reduced perceived appropriateness ratings and acceptance of novel food products (Schickenberg, Van Assema, Brug, & De Vries, 2008; Verbeke, 2015; Jaeger *et al*, 2019). More specifically, low levels of acceptance of meat

substitutes have been associated with food neophobia and current consumers of meat substitutes tend to be less neophobic (Apostolidis and McLeay, 2016, Giacalone, 2019). Another possible explanation for the weak relationships that we found between food neophobia and appropriateness ratings could be that not all protein foods included in the current research were relatively new on the Dutch market anymore. To specify, almost one-third of the consumers used meat substitutes and other protein-rich products once or twice a week. The consumers might be knowledgeable about the protein foods and repeated exposure (through consumption, media, and word of mouth) may have created familiarity. Consequently, the previous experience with the protein foods was likely to affect the situational appropriateness evaluations more than the level of food neophobia did.

Furthermore, the differences between the meat substitute consumption groups in the 2019-survey were quite distinct; 'heavy users' of meat substitutes gave higher appropriateness ratings to meat substitutes (Figure 5.2) and meat alternatives (Part 6A of the Supplementary Material of the paper) than 'medium', 'light' or 'non-users'. Situational appropriateness was medium to highly correlated to 'meat substitute consumption group' for most situations (Part 6B of the Supplementary Material). These differences in perceived appropriateness between meat substitute consumption groups were also found when only the non-vegetarian respondents (n=309) were taken into consideration (Part 6C of the Supplementary Material), meaning that the results were not too much influenced by the vegetarian respondents, who usually tend to eat meat substitutes more frequently than non-vegetarians. Familiarity heuristics could explain this positive correlation, because the more frequently a consumer uses a certain product, the more it will become familiar to that consumer. Several studies by Giacalone and Jaeger (2016) showed that familiar products were perceived as appropriate for a wider range of uses, which may be explained by the consumers' expectations of the sensory properties and safety of the products. We could not establish a causal relationship from our results. It could also be that respondents who generally find products more appropriate in usage situations, adopted meat substitutes into their lifestyles.

The same pattern between meat substitute consumption frequency and appropriateness ratings was also found in a study where respondents had to rate the appropriateness of meat substitutes in a meal context (Elzerman *et al*, 2015). In all types of meal contexts, i.e. different dishes, a clear increase in mean appropriateness ratings from non-, light, medium to heavy users of meat substitutes was found, even though the usage frequency of the heavy users was only 'at least once a week'. Repeated exposure has also been shown to increase the acceptance of meat substitutes. A home-use test of 10 weeks found a 'mere exposure effect' for meat substitutes for some respondents, where liking increased after repeated consumption of a meat substitute (Hoek et al, 2013). Moreover, consumers' familiarity with a product is related to higher situational appropriateness ratings, as summarized and elaborated by Giacalone (2019).

The appropriateness scores between the 2004- and 2019-surveys were surprisingly similar (Table 5.2). We expected to find higher overall appropriateness scores for meat substitutes

in 2019 than in 2004, because of the longer exposure of consumers to meat substitutes over the years, the larger assortment in the supermarkets and the greater attention in the media for meat substitution. However, this difference was not found. In contrast, mean appropriateness ratings of the meat substitutes by non-vegetarian respondents in 2019 were slightly lower than the ratings in the 2004-survey. However, further investigation of the two surveys with regression analyses showed that the overall appropriateness ratings in 2019 could be predicted from the usage frequency of meat substitutes and this was not the case in 2004. This means that in the 2004-survey, the more frequent users of meat substitutes did not give higher appropriateness ratings than the non- and light users. The non-users in 2019 gave much lower ratings than the non-users in 2004 and the heavy-users in 2019 rated overall much higher than the heavy users in 2004. It should be noted that there were less 'heavy users' of meat substitutes in the 2004-survey.

What could be the reason for this (in)dependence between appropriateness and meat substitute consumption frequency? In 2004, there was a much smaller variety of meat substitutes on the market (Elzerman, 2006; Hoek, 2006). Also, there was less attention to these products in the media. Appropriateness ratings of the non- and light users of meat substitutes in the 2004-survey might have been based on their image of these products and not on actual experience. The respondents who chose to participate in our study in 2004 probably had a positive attitude towards these products and this resulted in the relatively high appropriateness ratings of these consumption groups. In the 2019-survey, however, the low ratings that non- and light users gave might have been caused by a bad sensory experience with meat substitutes that these respondents once had and therefore they rejected the product category as a whole. A model on insect-based burgers shows that adoption of such a product is a result of sensory expectations and appropriateness, as experienced in previous tasting opportunities (Horvat, Fogliano, Luning, 2020). The fact that meat substitutes are positioned as a product to replace meat, means that consumers compare these products to meat, despite their sensory properties that often cannot yet compete with meat. Furthermore, it can take a long time before a 'rejecter' of a product finally gives the product a second chance and accepts it after all (ibid). Another explanation could be that some consumers just do not see the necessity of the replacement of meat and mainly focus on taste and culinary experience and that meat-eaters have very strong and persistent beliefs about the role of meat in daily life (Schösler, 2012; Hoek, 2011a,b). The higher appropriateness ratings of heavy users of meat substitutes in 2019 reflect that these consumers have adopted meat substitutes in their lifestyles and probably also that they do not keep comparing the properties of these products to the meat properties (anymore). Also, the need for meat in these consumer groups seems less, as can be concluded from the negative correlation between the appropriateness of meat products with meat substitute consumption. Ethical reasons like animal welfare, environmental concerns could play a stronger role now to more consumers than in 2004 (Apostolidis & Mc Leay, 2016).

Contextual factors were part of this study to learn about determinants beyond liking in the acceptance of meat substitutes. This information on situational appropriateness could guide product developers in the early stages of new product development. However, our research is not without limitations. Mainly practical reasons led to the present surveys using photographs, food names and description of the situations. Although the usage of 'immersive settings', i.e. well-defined descriptions of usage contexts can increase the ecological validity of a study (Jaeger, Porcherot, 2017), it could be that our context descriptions were too limited and not always applicable to (some of) our respondents (e.g. 'when I cook for children' or 'when I eat with vegetarians'). Furthermore, from the photographs of the products some respondents might have known exactly what product it was and based their answers on that specific product, whereas for others, the photograph represented the product category.

Our recruitment was performed via flyers in supermarkets and public buildings, as well as through social media of the researchers. Although we aimed for a diverse consumer sample with a naturalistic distribution of gender, age, consumption behavior, and FNS, many young, neophilic women took part in our study. The exploratory 2004-survey was completed by respondents who had already taken part in a central location test on meat substitutes. Therefore, their recent experience with meat substitutes could have influenced the results. Furthermore, the small consumer sample from 2004 (n=79) limits a thorough comparison between the two surveys.

5.5   Conclusions

This chapter shows that the situational appropriateness of meat substitutes is still lower than that of meat products. However, when familiarity with these products increases, so does the perceived situational appropriateness. Non-users of meat substitutes in 2019 had lower ratings than the non-users in 2004. Attention in product development and marketing should be paid to consumers that are now non-users of meat substitutes as different products and/or marketing techniques could be necessary for this group. Appropriateness should be taken into consideration in the development of new products aimed to replace meat.

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CHAPTER   6

Substituting meat and the role of

a situational context:

Exploring associations and motives of

Dutch meat substitute-users

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Abstract

The Dutch market for meat substitutes has grown steadily, however, their market share is still low, and meat consumption in the Netherlands is not decreasing. For a transition towards a more plant-based diet, understanding consumer motives regarding meat substitutes is important. The purpose of this study was to explore what motives lay behind the appropriateness of the use of meat substitutes in different usage situations. In total, 20 semi-structured in-depth interviews were performed to discover Dutch consumers' associations with the terms 'eating vegetarian' and 'meat substitutes', as well as motives regarding the situational appropriateness of meat substitutes. The most mentioned motives for eating vegetarian were 'environmental impact', 'health', and 'animal welfare', while meat substitutes were mainly eaten to replace meat in the meal. Most participants perceived vegetarian stir-fry pieces as appropriate for almost all situations; the appropriateness of other meat substitutes was more situation-specific. The thematic content analysis yielded seven categories for the motives given for the (in)appropriateness of the four meat substitutes in six usage situations: 'Functionality', 'Convenience', 'Properties', 'Preferences', 'Association with meat', 'Association with meals', and 'Nutrition'. Mainly motives in the categories convenience and functionality (function of the meat substitute in a meal) were mentioned for all situations and other motives were situation-specific. This exploratory study suggests that consumer motives should be taken into consideration in the design of new meat substitutes.

6.1 Introduction

Numerous studies underline the importance of a 'protein transition', i.e. the shift away from the consumption of animal proteins, such as meat and dairy, towards vegetable and new protein sources (e.g., Aiking, 2011; Smil, 2002; Tijhuis *et al*, 2011; van der Weele *et al*, 2019). The EAT-Lancet Commission on healthy diets and sustainable food systems advises a flexitarian diet, which is largely plant-based, but that can include modest amounts of meat, fish, and dairy (Willett *et al*, 2019). To achieve this, consumers do not all have to become vegetarians, but the reduction of meat consumption several days a week by increasing fruit, vegetable, and other plant-based food consumption could be a start to achieving these goals.

Meat substitutes, products that strive to resemble the (sensory) properties of meat, could facilitate this transition, mainly to win over consumers who are used to eating meat on daily basis (Elzerman *et al*, 2011; Hoek *et al*, 2011a). These products have been widely available in Dutch supermarkets for the last 30 years and their market share is growing steadily (de Waard, 2021; IRI Nederland, 2021). However, meat consumption in the Netherlands is not decreasing (Dagevos *et al*, 2020). Therefore, consumer researchers try to understand what are the important factors in the preference for meat and the acceptance of meat substitutes (e.g., Hoek et al, 2011a; Michel *et al*, 2020). First, not all consumers seem to see the need to substitute meat (Elzerman *et al*, 2013) and the habit of eating meat seems to be a barrier to the acceptance of meat substitutes (de Bakker and Dagevos, 2010). Consumers' drivers and barriers regarding the use of meat substitutes can be related to the sensory appeal, habits, familiarity, health, environmental factors, and concerns about the preparation of meat substitutes (Hoek et al, 2011a; Onwezen *et al*, 2021; Tso *et al*, 2021). Also, eating meat has been reported to be associated with maleness (Weinrich, 2018). Furthermore, the sensory properties of meat substitutes, such as texture, have been an issue in the acceptance, although these have improved over the years (e.g., Fiorentini *et al*, 2020). Another factor can be that consumers sometimes seem to need some time to get used to new products; some meat substitutes were better liked after repeated exposure (Hoek *et al*, 2013). Other factors, like promotion and word of mouth influence how familiar a new product becomes and how many consumers are willing to taste it. After rejection, it can take a lot of time before consumers are willing to try a new product again (Horvat *et al*, 2020).

Besides preferences, factors such as habits and beliefs about meat and meat substitutes, social norms on what foods are safe and appropriate to eat, affect food choice as well (Higgs, 2015). Normative eating behavior, such as the judgment of the appropriateness of foods in a situational context appears to be important in food acceptance (Schutz, 1988; Hersleth *et al*, 2015; Giacalone and Jaeger, 2019). A recent consumer survey on the situational appropriateness of meat substitutes investigated how meat products and their vegetarian counterparts matched with different usage situations (Elzerman *et al*, 2021). That study showed that, overall, meat products were rated as more appropriate than meat substitutes in almost all usage situations, and that different situations received different appropriateness

ratings. However, the *why* behind the situational appropriateness of meat substitutes remained unclear.

The main research question of this chapter is: what drives consumers of meat substitutes to use a meat substitute in a particular usage situation? The study could contribute to the insight into how consumer preferences regarding meat substitutes come into being. Furthermore, this information can be applied to develop meat substitutes that fit better in consumers' daily lives.

The objectives of this study are:

1. To gain insight into associations that Dutch meat substitute-users have with meat substitutes and eating vegetarian.
2. To find out typical motives behind the consideration of whether a meat substitute is (in)appropriate in a particular usage situation

6.2   Materials and methods

Meat substitutes and usage situations

Four meat substitutes that are available on the Dutch market were selected: vegetarian minced meat, vegetarian hamburger, vegetarian steak, and vegetarian stir-fry pieces (vegan chicken-like strips). These products are commonly used meat substitutes, except for vegetarian steak. The vegetarian steak was used as it was a newer product that is the vegetarian counterpart of a more luxurious meat product (steak) and therefore might give different results compared to the other products. No brand names or ingredients were given since we were interested in consumer response to the product type and not the specific products. The products were shown to the participants as a photograph; a product was presented in a transparent container without the brand package and without the plastic foil that is used for keeping the plastic container closed (as depicted in figure 2 for stir-fry pieces and vegetarian steak and the appendix for vegetarian mince and vegetarian hamburger).

Six usage situations were selected from the nine situations that were part of a previous survey (Elzerman et al., 2021).

The usage situations were phrased as follows:

Usage situation:	*Abbreviated in figures as:*
'when I eat with my family/household'	Family
'when I want to prepare a special meal'	Special
'when I eat alone'	Alone
'when I want to add flavor to the meal'	Flavor
'when I have little time to cook'	Time scarcity
'when I want to eat a healthy meal'	Healthy

In-depth interviews

The in-depth interviews consisted of two types of questions: association questions and questions about the situational appropriateness of specific meat substitutes. For the association questions, the participant was asked to mention his/her associations with the words 'eating vegetarian' and 'meat substitutes'. In these two first questions, no reference was made to any meat substitute nor a definition of meat substitutes was given; the associations were simply based on the participant's own experiences.

The appropriateness questions started with a brief introduction of each usage situation to familiarize the participant with the concept of usage situations. The meat substitutes were accompanied by a photograph of the specific meat substitute, with a generic product name and no further description or brand name. After introducing the meat substitutes and usage situations, questions regarding the appropriateness of the products in each usage situation were asked, e.g. "Which of these products do you consider to be appropriate in this situation?" and "What are your reasons for this consideration?". Some different follow-up questions per participant were asked for more clarification of certain answers.

The in-depth interviews were held and recorded via the Microsoft Teams video call program in December 2020 and January 2021 and lasted around 30 minutes each. The screen of the interviewer was shared showing a PowerPoint Presentation with the interview questions and the different meat substitutes.

Participant recruitment

This study was approved by the Social Sciences Ethics Committee of Wageningen University. For this explorative study, we aimed for a diverse group of Dutch participants, in terms of age, gender, and dietary habits. A promotional flyer with a brief description of the study was sent to consumers who had participated in a previous survey and indicated that they were willing to participate in future research. The response rate was 29.4% and the 20 recruited participants (3 males and 17 females) were between 20 and 74 years old (mean age 42.25 y.) and were selected because they were all users of meat substitutes. Their usage frequency of meat substitutes during the hot meal varied between less than once a month and 1-2 times per week. Non-users did not participate in this study, since they do not have experience with meat substitutes, so it is difficult to motivate the appropriateness of these products in usage situations. Both vegetarian and non-vegetarian respondents were part of this study, to obtain diverse perspectives on meat substitutes and to cover the range of possible motives. The demographic and consumption data of the participants are summarized in Appendix 1 of the paper. After the study, the participants received a gift card for their participation in the interview.

Moreover, the number of interviews needed was determined based on the degree of data saturation, i.e., the point at which no new information or themes are observed in the data (Guest *et al*, 2006). In this study, after evaluating the 20 interviews, it became clear that data saturation was reached after 16 interviews.

Data analysis

This research used a Thematic Content Analysis approach to analyze all the data that resulted from the in-depth interviews based on the qualitative data analysis described by Zanin *et al* (2021). The data analysis started with transcribing the verbal data of the recordings from the in-depth interviews. The transcripts of the interviews (raw data) were carefully read and sections of answers, that answered an interview question, were grouped. After categorizing the answers of all the transcripts, units of analysis were selected. Next, the whole context of these units of analysis (i.e., sentences before/after the units of analysis that gave meaning to the units of analysis) was noted, which were called context units. All context units were compared and, if possible, grouped when they had the same meaning. A core of meaning was assigned to these grouped context units. As cores of meaning could be related to each other, they were further grouped into different categories. The frequency with which motives in a category were mentioned was counted for every usage situation, and if a participant mentioned a motive just for one of the products, it was counted as 1, but if the participant specifically mentioned that this motive also applied to the other products, the motive was counted again. MAXQDA 2020 (VERBI Software, 2019) was used to further analyze and visualize the data. The second author performed the data analysis, and the first author checked and agreed on the classification of all context units into cores of meaning and categories. The choice of relevant quotes was discussed among the authors. This was done to improve the reliability of the data.

6.3   Results

Associations with 'eating vegetarian' and 'meat substitutes'

To get insight into how the product category of meat substitutes was perceived, respondents were asked to give their associations with the terms 'eating vegetarian' and 'meat substitutes'.

Figure 6.1A shows the associations of the participants with 'eating vegetarian'. The participants often mentioned product-related properties, such as 'no meat', 'alternative protein products', and 'meat substitutes', as illustrated in the following quote:

> *'I think about a meal without any meat or fish. This can be prepared with or without substituting the meat. So, just a meal without meat.' [participant 11]*

This question also elicited reasons for eating a vegetarian meal or diet, such as the environmental impact of meat consumption, health reasons, and animal welfare, as demonstrated in the following quote:

> *'We are doing this, because: (A) we think a lot of meat is not healthy, and (B) it is better for the world if everyone eats less meat from intensive animal farming.' [participant 6]*

Figure 6.1B shows the associations of the participants with the term 'meat substitutes'. The participants either related 'meat substitutes' with different product types or gave arguments

for eating meat substitutes. Moreover, the participants often mentioned specific meat substitutes, as stated in the quote below:

'Nowadays, there are a lot of meat substitutes, such as vegetarian minced meat, but there are also vegetarian chicken pieces that can be used in all kinds of dishes.' [participant 10]

When participants gave motives for eating 'meat substitutes' it was often related to 'nutrient source', followed by 'traditional meat replacement' (see Figure 6.1B). As demonstrated in the quote below.

'I think it can yet be a way of taking in proteins. Especially when you eat a traditional meal with "potatoes, vegetables, and meat". Without the meat, it is not complete. If you then add a meat substitute, I think you will still receive some of the nutrients that are usually in meat.' [participant 5]
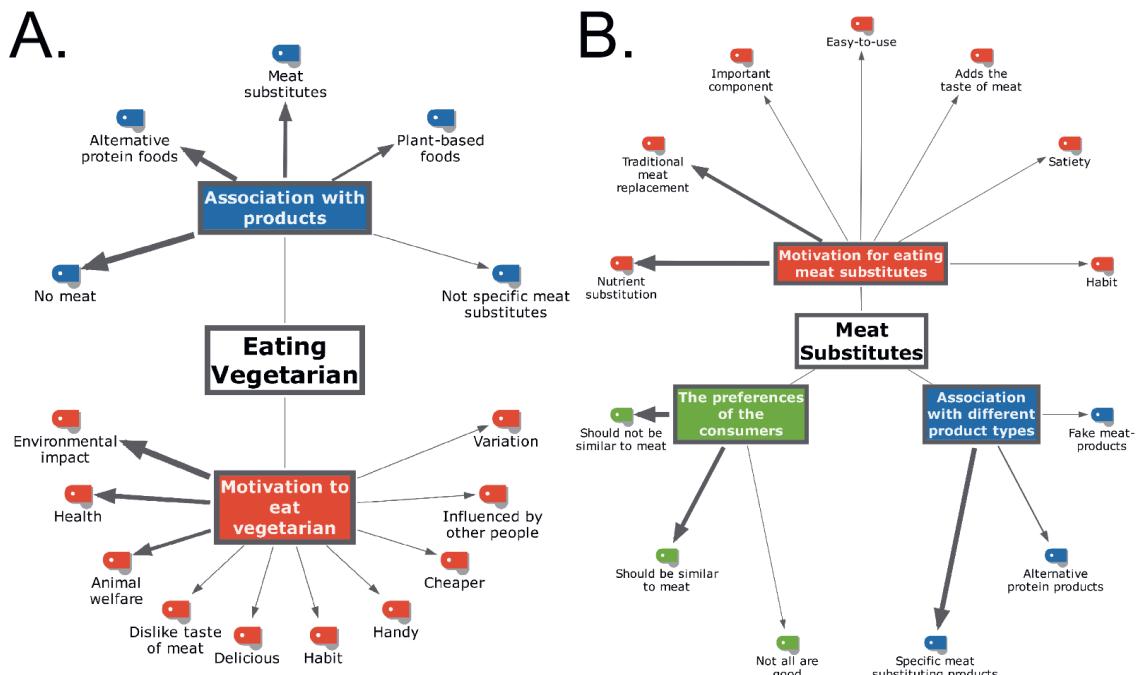
Figure 6.1   Associations with the words 'eating vegetarian' (A) and 'meat substitutes' (B), as mentioned during the in-depth interviews (n=20). A thicker arrow means that an association is mentioned more frequently.

When participants expressed their associations with 'meat substitutes', it was often mentioned that meat substitutes should not be similar to meat products (see Figure 6.1B), although other participants reasoned that meat substitutes should be similar to meat products. These two different opinions are reflected in the following quotes:

'We have been vegetarians for such a long time now that we prefer meat substitutes that do not look and taste like meat. Appearance is not that important, but I do think that the nutritional value should be close to that of meat.' [participant 3]

'If you want your meal to have a certain mouthfeel, then it is important that meat substitutes are almost similar to meat.' [participant 19]

Perceived appropriateness of meat substitutes in different usage situations

In the next step of the interviews, the participants were asked to indicate per usage situation, which meat substitutes they found appropriate. Table 6.1 presents how many participants indicated the appropriateness of the four different meat substitutes in the six different usage situations. Most of the participants expressed vegetarian stir-fry pieces and vegetarian mince to be appropriate in almost every usage situation except for the usage situation 'cooking a special meal'. Almost all (19) respondents indicated vegetarian hamburgers to be appropriate in the situation when cooking with time scarcity. The vegetarian steak was mentioned as appropriate by the smallest number of respondents for every situation, except for 'cooking a special meal'. In this situation, 7 of the 20 respondents found the use of vegetarian steak to be appropriate.

Table 6.1   Number of participants that indicated a meat substitute to be appropriate in a usage situation (n=20)

Usage Situation	Meat substitute			
	Vegetarian Stir-Fry Pieces	**Vegetarian Mince**	**Vegetarian Hamburger**	**Vegetarian Steak**
Eating Alone	11	10	16	8
Eating with family/household	17	19	13	8
Cooking a Healthy Meal	14	10	8	7
Cooking with time scarcity	18	16	19	11
To add flavor to the meal	12	10	10	7
Cooking a special meal	8	4	4	7

Motives for the (in)appropriateness of meat substitutes in different usage situations

To get insight into reasons behind *why* meat substitutes are (in)appropriate in a usage situation, respondents were asked to mention motives of why they would or would not use a meat substitute in a particular situation. The thematic content analysis yielded in total 7 categories of motives, as shown and defined in Table 6.2. The motives were categorized into 'functionality', 'convenience', 'properties', 'preferences', 'association with meat', 'association with meals', and 'nutrition'. Depending on the usage situation, participants gave different types of motives, e.g., the usage situations 'when I have little time to cook' and 'when I want to cook a special meal' yielded mainly motives that were associated with the duration of particular types of meals, while motives in the category 'nutrition' were mainly mentioned for the situation 'when I want to cook a healthy meal' and occasionally for the situation 'when I eat with my family/household'. Most motives that were mentioned fell in the category 'functionality' and were about the role that the meat substitute has in a meal, such as 'product completes the meal', 'product does (not) blend well with other ingredients', or 'product does not give added value to the meal'.

Other motives that were mentioned by many participants regarded the association that they had with particular types of meals, product properties, and the convenience of the product. Many participants mentioned motives in the category 'convenience' for all four meat substitutes (e.g. 'easy to prepare', 'almost ready to eat, and 'easy to divide into smaller portions'). These motives were mentioned for the situations 'when I have little time to cook', 'when I eat alone', and 'when I eat with my family/household'.

Meat substitutes were not often related to their meat counterparts; participants gave fewer motives that were related to meat(products), such as that the meat counterpart was more or less appropriate or healthier.

Some participants explained the inappropriateness of a meat substitute in a situation by mentioning their preferences for other meal components, such as meat, vegetables, or other meat substitutes.

Figure 6.2 shows the most mentioned motives for the (in)appropriateness of vegetarian steak and stir-fry pieces in the six usage situations. The motives for vegetarian hamburgers and mince are shown in the Supplementary material since they were somewhat similar to those for vegetarian steak and stir-fry pieces respectively. Zooming into the four different meat substitutes, several similarities and differences stand out. Vegetarian stir-fry pieces and mince overall received more positive motives than vegetarian steak and hamburger. Also, the most mentioned motives for every usage situation were mostly positive for stir-fry pieces and mince, while vegetarian steak mainly received more negative motives for the situation 'when I want to cook a healthy meal'.

Most positive motives were about the fast and easy preparation of the product, suitability for specific recipes, and healthiness of the products, whereas most negative motives were

about the taste, the unhealthiness, and the association that meat substitutes are not suitable for a special occasion.

Vegetarian stir-fry pieces, vegetarian mince, and vegetarian hamburgers were often associated with a quick meal, whereas vegetarian steak was more often associated with an extensive dinner.

Table 6.2: Categories of motives that emerged from the thematic content analysis. The motives were given for the (in)appropriateness of the four meat substitutes in the six usage situations, definitions of the categories, examples of the motives, and the frequency that motives in a category were mentioned.

Category	Motives in this category refer to...	Examples of motives	Frequency per usage situation					
			Alone	Family	Healthy	Time scarcity	Flavor	Special
Functionality	Role of the product in meals	Product fits in special recipes / Product is useful for in advance meal preparation / Product fits in a specific meal	48	39	0	4	59	20
Convenience	Convenience of the product	Product is easy to prepare / Product is easy to divide into smaller portions	37	35	0	31	0	0
Properties	Intrinsic and extrinsic product properties	Product is (not) tasteful / Portion size is too big	31	6	2	34	14	12
Preferences	Preferences for other products or preferences of others	Preference for the meat variant / Preference for other vegetarian options / Depends on other table companions	10	9	19	0	8	22
Association with meat	Associations with a meat product	Meat variant is also (in)appropriate / Healthier than the meat variant	4	12	10	4	5	10
Association with meals	Associations with a meal type	Product is associated with extensive dinners / Product is associated with fast meals / Product is associated with (un) healthy meals	2	0	24	38	3	42
Nutrition	Nutritional content of the meat substitute	Product provides nutrients / Product contains little fat / Product contains a lot of additives	0	8	71	0	0	0

Figure 6.2   Motives for the appropriateness (green) or inappropriateness (red) of the use of vegetarian steak (2A) and vegetarian stir-fry pieces (2B) in the six usage situations, as mentioned in the in-depth interviews (n=20). Motives that are included in the figures were mentioned by at least three participants for a situation and the thicker the arrow, the more often a motive was mentioned.

6.4   Discussion

This exploratory study investigated what drives consumers of meat substitutes to use a meat substitute in a particular usage situation. The associations with the terms 'eating vegetarian' and 'meat substitutes' were identified and consumers' underlying motives behind the perceived situational appropriateness of four different meat substitutes in six different situations were assessed. Our findings show that the respondents associated 'eating vegetarian' mainly with the omission of meat, and with the reasons behind this, such as environmental impact. Consumer awareness of the large environmental impact of meat seems low and therefore environmental reasons do not seem to be a major motive for reducing meat intake in the Western population (Sanchez-Sabate and Sabaté, 2019; Hartmann and Siegrist, 2017). However, Vanloo *et al* (2017) found consumer segments, based on the involvement in sustainable eating; the more involved consumers had a more plant-based diet. In the current study, the participants were all users of meat substitutes, and some of them were vegetarians. Vegetarians are more likely to agree that meat production is bad for the environment (Mullee et al., 2017). 'Health' and 'animal welfare' were also often associated with 'eating vegetarian' in our study. Several other studies also showed that health considerations and animal welfare were motives for people to become vegetarian or reduce meat consumption (Sanchez-Sabate and Sabaté, 2019; Hartmann and Siegrist, 2017; de Boer and Aiking, 2017; Mullee et al., 2017). Furthermore, a need for variety and the interest in new tastes and new foods were illustrated as drivers for considering a more vegetarian diet for light to medium meat-eating consumers (Mullee et al., 2017; Hoek et al., 2011). Variation was only mentioned by a few participants in the present study and to discover new tastes was not mentioned at all.

The term 'meat substitutes' evoked different associations: some respondents mentioned that meat substitutes should be similar to meat, whereas others preferred products to be dissimilar to meat. This was also found in previous focus group discussions; some consumers mentioned that they would rather buy meat substitutes that resembled meat as it was easier to prepare a dish with them, whereas others brought forward that meat substitutes needed to have an identity of their own (Elzerman et al., 2013). In another study, heavy users of meat substitutes tended to prefer sensory properties that are dissimilar to meat, possibly because these consumers often have a predominantly vegetarian lifestyle (Hoek *et al*, 2011a). On the other hand, low users of meat alternatives preferred meat-like products (Michel *et al*, 2021). Hoek *et al* (2011b) pointed out that unfamiliarity with meat substitutes was a key barrier for non-users and light to medium users, which might explain why some participants in the current research preferred meat substitutes to be similar to meat. 'Nutrient substitution', the substitution of proteins or other nutrients which was normally provided by meat, was also often mentioned as an association with 'meat substitutes' which is in line with previous research (Elzerman *et al*, 2013). Likewise, health and nutritional quality were shown to be important drivers of consumer interest in alternative proteins (Tso *et al*, 2021).

To find out typical motives behind the consideration of whether a meat substitute is (in)appropriate in a particular usage situation, the interviews were set up to direct

participants to think about how they would behave when cooking a meal with the meat substitute and how they envisioned it to be part of that meal. Our study discovered that motives can be grouped into different categories. These categories were inductively identified from the qualitative information from the interviews and underlined what type of information participants shared to substantiate the appropriateness of meat substitutes in usage situations. Participants mainly gave motives and associations that had to do with the meat substitute product itself or with its role in a meal. They expressed motives about product characteristics of meat substitutes (captured in the categories Properties, Convenience, and Nutrition), the role of the meat substitute in a meal (categories Functionality and Association with meals), specific preferences (Preferences), and direct relation to the meat counterpart (Association with meat).

Several motives in the category of Convenience were mentioned often. All products were mentioned to be 'easy to prepare', especially in the situation 'time scarcity', which was also one of the outcomes of previous focus groups (Elzerman *et al*, 2013). Especially the vegetarian hamburger was often mentioned combined with these motives, as also reflected in the previous survey, where both normal and vegetarian hamburgers rated high on appropriateness when cooking with time scarcity (Elzerman *et al*, 2021). According to another study, consumers grouped normal meat hamburgers and vegetarian hamburgers in the same product category (Hartmann and Siegrist, 2017). Furthermore, the four meat substitutes were also associated with being almost ready to eat, easy to store in the freezer, and easy to divide into smaller portions, motives that also fell in the category of Convenience. Whether the convenience of a product is seen as a positive characteristic depends on the type of consumer. Bernués *et al* (2012) distinguished four consumer segments regarding the convenience of lamb meat and showed that satisfaction derived from cooking, time spent on cooking, and preference for certain types of recipes were of different importance to the different segments. Although there is a market for convenient home cooking (Leroy and Degreef, 2015), the time that consumers wish to spend on cooking varies. This could imply that also for some of our participants, convenience had a merely positive meaning, whereas others might not be able to use their creativity in the preparation of a meal with meat substitutes.

In the category Properties, extrinsic product properties, such as price and portion size, as well as intrinsic properties, like taste and texture were captured. Although many studies concluded that the sensory appeal of meat substitutes is low and that the sensory properties should be improved (Weinrich, 2018; Fiorentini *et al*, 2020; Michel *et al*, 2021), a bad sensory appeal was not often mentioned as such in our study. However, e.g., 'bland taste' and 'preference for other vegetarian options' could also refer to the sensory properties of the products. Mainly for vegetarian steak and in the situations 'when I have little time to cook', 'eating alone' and 'to add flavor to the meal' it was mentioned that the meat substitute was not liked well or was not tasty. An explanation for this could be that the vegetarian steak is a relatively new product and the counterpart of a steak, which is often seen as a high-end product of which the sensory properties are highly valued, which is in line with the findings

of Michel *et al* (2021). Conversely, the other products (vegetarian hamburger, vegetarian mince, and vegetarian stir-fry pieces) might have been more familiar to the participants. Familiarity is a predictor of the acceptance of plant-based meat substitutes (Bryant *et al*, 2019). Moreover, the mince and the stir-fry pieces are commonly used as an ingredient in a dish and therefore their sensory properties could be less important since those can be masked when eaten in a dish. Meal context has been shown to improve the acceptance of meat substitutes in a central location test (Elzerman *et al*, 2011).

Another explanation for the few hedonic associations that were mentioned could be that appropriateness questions elicit answers based more on cultural norms and less on liking (Giacalone and Jaeger, 2019). Consumers tend to focus on the fulfillment of the goals that are associated with a particular consumption situation, and not just on personal preferences and product characteristics (Giacalone, 2019). For some of the meat substitutes and usage situations in our study, other factors might have been more important in the situational appropriateness, as the following quote illustrates:

> *'I would not buy meat substitutes when I'm cooking for myself. Maybe because of the price, meat substitutes aren't really expensive, but they aren't cheap either' [participant 3]*

Nutritional product properties were summarized in a separate category to get more insight into the nutritional and health considerations of the participants since health aspects are drivers of consumer acceptance of meat alternatives (as reviewed by Onwezen *et al*, 2021). Although health aspects were mentioned as associations with the more general question on 'eating vegetarian', these aspects did not seem to be important drivers of the appropriateness of meat substitutes in all usage situations. Nutritional and health aspects seem to be important factors when cooking a healthy meal and were also mentioned when making dinner for the family (Table 6.2). Both negative and positive nutritional factors were mentioned, as in the following quotes:

> *'Vegetarian steak and hamburger...it is questionable how healthy those products are.. Sodium, fat, artificial..' [participant 9]*

> *'I see them all as healthy. All good things of meat are in the meat substitutes, like proteins and I also think they added B-vitamins' [participant 8]*

Nutritional advantages and concerns regarding meat substitutes were also expressed during focus group discussions (Elzerman *et al*, 2013). Consumers seem to be unsure about the health benefits of meat substitutes (Onwezen *et al*, 2021).

The categories Functionality and Association with meals represented associations that participants made with specific recipes, meals, or preparations (Functionality) or with the role the meal was taking in their diets (Association with meals). In the category Association

with meals, participants mentioned the length or the healthiness of the meals. One of the participants mentioned:

> *'I associate steak with extensive dinners, so, no, a vegetarian steak I would not use if I had little time to cook'*

In the category Functionality, most participants mentioned a specific dish when they were discussing the appropriateness of a meat substitute in a usage situation. This was mainly for mince and stir-fry pieces, meat substitutes that can be used as an ingredient in a dish, as shown in this quote:

> *"My mother sometimes makes 'Chicken tikka masala.' When I made it myself, I used vegetarian stir-fry pieces instead, because without chicken it was a lonely sauce." [participant 5]*

Other motives in this category were more general:

> *'When you want to cook a nice 'fancy' vegetarian dish, you are not going to use these things. Meat substitutes are more ordinary' [participant 13]*

Motives for the situation 'when cooking something special' are mostly associated with particular types of meals (e.g., 'product is associated with something special', 'product is not associated with extensive dinners', and 'product is associated with regular meals') (see Figure 6.2). Especially, vegetarian steak is associated with something special (see Figure 6.2a), although the big majority preferred the meat variant, as expressed by one of the participants:

> *'I would not choose the vegetarian steak. If you want to eat something like a steak, you can better eat a real steak once a week and eat vegetarian for the rest of the week' [participant 4]*

These findings match with the results of our previous survey, where a normal steak received high appropriateness ratings for 'cooking something special', and the vegetarian steak was perceived as much less appropriate (Elzerman *et al*, 2021).

Other motives in the category Preferences included the choice of other vegetarian options over meat substitutes:

> *'When I want to eat a really healthy meal, I take beans and lentils' [participant 9]*

Besides expressed preferences, some participants compared the meat substitute to the meat variant when thinking about situational appropriateness. These motives were summarized in a separate category, to get an idea of the importance of this comparison. Only a few of the respondents expressed such a comparison, by comparing the nutritional value or the appropriateness of the meat and meat substitutes, as stated in the following quote:

> *'I think the normal hamburger would also be appropriate if you have little time to prepare your meal. I do not think the vegetarian variant needs more time to cook.' [participant 5]*

Surprisingly, most participants did not mention any comparison to the meat variant. This suggests that those participants considered meat substitutes as a product category by itself, and not just as substitutes for meat.

In the current exploratory study, we aimed to get a broad range of perspectives on meat substitutes and their situational appropriateness. The obtained results are of importance for

the understanding of consumer acceptance of meat substitutes and can direct food companies in their development of new meat substitutes. For policymakers, the nutritional and environmental aspects of meat and meat substitutes could be further researched and communicated to consumers (Santo *et al*, 2020) and there is a role in the education of children to get them acquainted with meat alternatives since the parents' attitudes and attachment to meat seem to play a crucial role in children's meal choice (Erhardt and Olsen, 2021).

Our research has several limitations. The participants were comprised of both vegetarian and non-vegetarian respondents, to get a wide range of motives. We did not aim to compare these groups. Although data saturation was reached in our study, care should be taken when generalizing the results. To keep the interview feasible for the interviewees, four meat substitutes and six usage situations were used. Other products or situations could elicit maybe more motives. Furthermore, our participants were all Dutch and the generated associations and motives could differ from other countries/cultures. Cultural factors play a role in the perception of meat and insects (Schössler *et al*, 2015; Onwezen *et al*, 2021), so may also be of importance to the perceived appropriateness and acceptance of meat substitutes. Furthermore, only a few men participated in this study. Although men gave similar ratings and only sometimes slightly lower ratings in a previous study on situational appropriateness of meat substitutes (Elzerman *et al* 2021), other studies underlined the importance of gender differences regarding meat, meat substitutes, and vegetarianism (Trelohan, 2021; Rosenfeld and Tomiyama, 2021). Moreover, all participants were users of meat substitutes and therefore might have been more interested in meat substitutes. Possibly, they were among the 'early adopters' or 'early majority' that accepted meat substitutes, when looked at from the diffusion of innovation theory (Rogers, 2003). Knowing the motives and barriers of consumers that are more at the forefront of the innovation adoption curve could also help to understand consumers who are not yet ready to adopt meat substitutes (Gonera *et al*, 2021). The environmental issues involved with meat production are not yet considered important drivers for the consumers who are reluctant to try meat substitutes and the possible environmental advantage of meat substitutes is not recognized by them. More visible benefits of meat substitutes should be promoted by marketers to win these consumers over (Szedja *et al*, 2020). Future research, such as a quantitative survey, could identify differences between motives of non-users and users of meat substitutes, different cultures, and could make use of more combinations of meat substitutes and usage situations. That data could then be used as a basis for theory development of what factors play a role in the situational appropriateness of meat substitutes.

6.5   Conclusions

Eating vegetarian was associated with the omission of meat and with the environmental impact of meat production, health aspects, and animal welfare. Meat substitutes were associated with nutrient substitution, preferences regarding the (dis)similarity to meat, and

specific meat substitutes. Consumer motives for the situational (in)appropriateness of meat substitutes can be grouped into several categories regarding the meat substitute product itself (categories Properties, Convenience, and Nutrition), the role of the meat substitute in a meal (Functionality and Association with meals), specific preferences (Preferences) and direct relation to the meat counterpart (Association with meat). Easy and fast preparation were drivers of the situational appropriateness of all four meat substitutes and the mince and stir-fry pieces received mostly positive motives. Barriers for vegetarian steak and hamburger were the taste, preference for the meat variant, nutritional factors, and the image of the product. Overall, meat substitutes fitted better in everyday eating situations and were less appropriate for special occasions. The current study suggests an image of meat substitutes as being processed, ordinary and convenient, which are useful insights for the R&D and marketing of plant-based meat substitutes. To convince more and other consumers, the focus might need a shift towards less processed products, with a more natural image and recipe ideas for more extensive cooking. Furthermore, there is a role for policymakers and education to get adults as well as children acquainted with the benefits and use of meat substitutes.

Whether it can be generalized that underlying motives behind appropriateness is context-specific should be part of future research.

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CHAPTER   7

General Discussion

7.1   Background

The need for a transition from a merely meat-centered diet to a more plant-based diet has been widely recognized, but this process is complex and slow (Willett et al, 2019). One way to reduce the consumption of meat is to replace the meat in a meal with meat substitutes, products that are developed for this purpose. The sensory quality of meat substitutes has improved over the last decades and the meat substitute market has expanded (van Teefelen and van den Boom, 2019). However, it is currently still only 4,5% of the meat market and meat consumption in the Netherlands is not declining (Beekman, 2021). This thesis aimed to investigate consumer acceptance of meat substitutes and the role that contextual factors play in this. This research started in an exploratory way, to grasp consumers' opinions and attitudes towards meat substitutes and to scan their responses toward the concept of 'appropriateness'. Meal context was further researched in a web-based survey and a Central Location Test, whereas the concept of situational context was worked out via web-based surveys and semi-structured in-depth interviews. These interviews also revealed consumers' associations and motives toward meat substitutes.

7.2   Main findings

Table 7.1 gives an overview of the study design and states the contribution of the main findings to the insights on meat substitutes from the perspectives of product, context, and consumers.

Chapter 2 explored the experiences and perceptions that consumers had of meat substitutes as well as the concept of appropriateness. Consumer focus group discussions revealed that health aspects and easy preparation were regarded as positive aspects of meat substitutes, whereas lack of information on the package, and high price were reported as negative. Sensory attributes such as neutral taste or tastiness, crispiness, chicken-like texture, or granular texture were seen as positive attributes. Sensory attributes that were mentioned as negative were a uniform taste, compactness, dryness, and softness. Most consumers found the use of meat substitutes appropriate in the dishes that were presented to them in photographs.

The concept of appropriateness was further investigated via a web-based survey about meat substitutes in a meal context. *Chapter 3* describes this survey on the appropriateness, attractiveness, use-intention, and (un)desirable sensory properties of meat substitutes in different dishes based only on visual information. The most appropriate meat substitute–meal combinations were those that are similar to common Dutch meal combinations (e.g., spaghetti with minced meat and rice with chicken pieces). Attractiveness and intention scores were in line with the appropriateness scores. Furthermore, we found that users of meat substitutes and younger respondents gave higher appropriateness ratings. This study

demonstrated that the appropriateness of meat substitutes in a dish is related to attractiveness and use intention.

To investigate meat substitutes and the role of meal context and appropriateness in a consumption study, a central location test was performed, as described in *Chapter 4*. Meat substitutes with similar flavor and texture, but with different shapes (pieces and mince), were rated differently in four meals (rice, spaghetti, soup, and salad) on product liking, appropriateness, and intention-to-use, but not differently on overall liking of the meals. Meat substitutes with similar shapes, but different flavors and textures rated differently on overall liking when tasted as a separate ingredient, but did not always differ in product liking when tasted in a rice meal. Appropriateness seemed to be influenced by the appearance of the meat substitute-meal combination, and less by the experienced flavor and texture.

Besides meal context, the influence of situational context on the appropriateness of meat substitutes was studied. *Chapter 5* describes the study on perceived situational appropriateness of meat, meat substitutes, and other meat alternatives in different usage situations using an item-by-use appropriateness survey. Overall, meat products were perceived as more appropriate than their vegetarian equivalents (e.g., hamburger vs. vegetarian hamburger) in almost all situations. Meat alternatives (chickpeas, nuts) scored generally higher than meat substitutes on situational appropriateness. Age and gender affected appropriateness ratings: women and younger respondents gave higher ratings to meat substitutes and meat alternatives. Food Neophobia showed to be a small effect.

The *why* behind the differences in perceived situational appropriateness was studied in *Chapter 6*. It describes in-depth interviews aimed at understanding consumers association with vegetarian and meat substitutes and their motives regarding the situational appropriateness of meat substitutes. The term 'Eating vegetarian' was mostly associated with 'no meat' and 'alternative protein foods' and the most mentioned motive for eating vegetarian was 'environmental impact', followed by 'health' and 'animal welfare'. 'Meat substitutes' were mostly associated with 'specific meat substituting products' and the most mentioned motives were 'nutrient substitution' and 'traditional meat replacement'. Most participants perceived vegetarian stir-fry pieces as appropriate for almost all situations. The thematic content analysis yielded seven categories for the motives given for the (in)appropriateness of the four meat substitutes in six usage situations: 'functionality', 'convenience', 'properties', 'preferences', 'association with meat', 'association with meals', and 'nutrition'. Mainly, motives in the categories convenience and functionality (i.e., the function of the meat substitute in a meal) were mentioned for all situations and other motives were situation-specific.

Overall, the Dutch meat-eaters that participated in the studies in this thesis were generally open to meat substitutes, but sensory properties of current meat substitutes and ignorance of how to prepare a meal with meat substitutes are still barriers to the use of meat substitutes. Meat substitutes are seen as convenient products that are suitable for a meal at

home with the family, but not for special occasions, such as preparing a special meal for friends. Meat substitutes are overall perceived as less appropriate than meat for use in different situations. However, when the usage frequency of meat substitutes increases, so do the appropriateness ratings, suggesting that familiarity plays an important role in the appropriateness and acceptance of meat substitutes. Furthermore, the combination of the meat substitute and the meal, and not so much the meat substitute itself, determines the acceptance of these products.

Table 7.1 Summary of the main findings of the studies in this thesis on consumer acceptance of meat substitutes and the roles of product, context, and consumer characteristics (N= number of participants, m.s. = meat substitutes).

Method; respondents	Design — Main topics	Main findings — Product	Main findings — Context	Main findings — Consumers
Chapter 2				
Focus group discussions; N= 46	Reasons for eating m.s. / Experience with m.s. / Sensory expectations / Meal context	*Positive aspects*: convenience, health / *Negative aspects*: price, information / Both positive and negative sensory attributes mentioned	Consumer responses towards m.s. were more positive when used in meals	Main reasons for eating m.s.: Curiosity, variation, health, and concerns regarding livestock production
Chapter 3				
Survey; N= 251	Meal context and appropriateness / Sensory expectations	Appearance and shape of m.s. were important for appropriateness in a meal / Brown color most preferred for m.s. / Other sensory aspects	Dishes differed in perceived appropriateness of m.s.	More frequent users and younger respondents gave higher ratings
Chapter 4				
Central Location Test; N= 93	Consumer liking / Meal context	The shape of the m.s. was important for product liking, appropriateness, and use intention.	Appropriateness was mainly influenced by the combination of the m.s. and type of meal. / M.s. with similar shapes, but different flavors and textures rated differently on overall liking when tasted separately, but did not always differ in product liking when tasted in a rice meal.	
Chapter 5				
Surveys; N= 388 (in 2019) and N=79 (in 2004)	Situational context	Meat was perceived as more appropriate in most situations than m.s. / Meat alternatives (pulses, nuts) scored higher than m.s.	M.s. often followed the same situational appropriateness profile as meat but were overall less appropriate. / All m.s. were rated low on appropriateness in a special meal and some rated higher than meat in a healthy meal.	Younger respondents and women, as well as more frequent users of m.s. gave higher appropriateness ratings to m.s.
Chapter 6				
Semi-structured interviews; N= 20	Consumer motives regarding situational appropriateness of m.s.	Motives for eating vegetarian were environmental impact, health, and animal welfare. / Motives for eating m.s. were mainly the substitution of nutrients or meat	Motives for the (in)appropriateness of m.s. in situations can be grouped into seven categories: 'functionality', 'convenience', 'properties', 'preferences', 'association with meat', 'association with meals', and 'nutrition'. Mainly motives in the categories convenience and functionality (function of the m.s. in a meal) were mentioned for all situations and other motives were situation-specific.	

7.3   Interpretation of the results

This thesis described factors in consumer acceptance of meat substitutes and tried to explain the possible reasons behind the slow acceptance process of these products. Several conceptual models describe these factors (i.e., the food, the context, and the consumer) as important for food choice (e.g., Randall and Sanjur, 1981; Shepherd, 1989; Dacremont and Sester, 2019). The acceptance of meat substitutes is looked into from three perspectives: the product characteristics of meat substitutes, contextual factors around the consumption of meat substitutes, and consumer characteristics of users of meat substitutes.

Product characteristics perspective

The product characteristics of meat substitutes can influence consumer acceptance. Consumers expressed desirable and undesirable product properties in the qualitative studies (Chapters 2 and 6) as well as in the web-based survey on appropriateness and sensory expectations (Chapter 3). 'Bad sensory appeal' was the initial problem statement of this research (Elzerman, 2006), and was expressed by respondents during the focus group discussions, however, it was still mentioned by respondents in the in-depth interviews in 2021. The sensory properties of meat substitutes have been a point of concern over the years, despite the growing meat substitute market and technological advances (Hoek et al, 2011a; Ilic, van den Berg & Oosterlinck, 2021). Especially the texture (e.g., juiciness) of meat substitutes seems to be a problem (Schouteten *et al*, 2016).

The nutritional and health aspects of meat substitutes also play a role. Concerns about macronutrients (proteins, fat) and micronutrients (too little vitamins and iron, and too much salt and additives) were expressed in both the focus group discussions (Chapter 2) and in-depth interviews (Chapter 6). Some respondents also pointed out that they perceived these products as artificial and fake, and high in salt content and additives (Chapters 2 and 6). This is in line with findings by Michel, Hartmann, and Siegrist (2021), who showed meat products were rated as more natural products and meat substitutes more as artificial. Nevertheless, some respondents indicated that they found meat substitutes to be healthier than meat because they are plant-based and contain less fat. The ambivalence towards the health aspects of meat substitutes indicates that consumers struggle with the image of meat substitutes as being a healthy alternative to meat (Weinrich, 2018; Tosun *et al*, 2020). Interestingly, this dual image also applies to the health perception of meat (Geurts *et al*, 2017).

Sustainability and environmental reasons for the choice of meat substitutes were often mentioned in the in-depth interviews, but not in the focus group discussions. In 2011, Hoek *et al* (2011a) concluded that environmental aspects were for most consumers no drivers to eat meat substitutes, and therefore marketing campaigns should not focus on this aspect.

However, it could be that consumers are now more aware of the environmental burden of the meat industry and consider these aspects in their food choice (Sanchez-Sabate and Sabaté, 2019), as suggested by the high number of consumers who consider themselves flexitarians (Dagevos, 2021).

Chapters 2, 5, and 6 also show that meat substitutes are considered convenient products that are fast and easy to prepare. However, some consumers who are not so familiar with these products indicate that they find it difficult to prepare a dish with meat substitutes and express they would like more information, in line with findings by Weinrich (2018) and Varela *et al* (2022).

The product characteristics of meat substitutes should be seen in light of how meat is perceived by consumers. Should meat substitutes mimic meat? Although the most mentioned desirable color for a meat substitute was brown, consumers differed in their opinions on whether a meat substitute should resemble meat. These findings are in line with Hoek et al (2011b), who stated that some resemblance to meat is necessary for consumers to recognize meat substitutes as alternatives to meat. Schösler et al (2012) found that the less frequently consumers used meat substitutes, the more they wanted them to be similar to meat.

To many consumers, the image is that meat is a nutritious, tasty, and versatile product. Meat is being used in simple and quick meals as well as luxurious dinners (Chiles and Fitzgerald, 2018). We found that meat substitutes can't yet fully compete with meat (Chapters 5 and 6), as shown by their lower situational appropriateness (see figure 5.1), remarks by respondents in the qualitative parts of this thesis (Chapters 2, 3, and 6), and the 'benchmarking' of meals with meat substitutes or chicken pieces (Chapter 4). On the other hand, our studies also point out that the reputation of meat is not only positive. Some respondents expressed that their interest in meat substitutes was initiated out of concern about meat scandals, animal welfare, and the environmental burden and indicated that meat substitutes are more appropriate for healthy meals than meat products (chapters 2 and 6). These health and environmental arguments were not always mentioned as important by meat-eating consumers (Hoek *et al*, 2004), and the importance of these factors seems to be culture-dependent (Weinrich, 2018). Finally, meat substitutes are products that are produced to substitute meat in a meal and this definition underlines one of the issues in consumer acceptance: a substitute, whether or not named as such, gives the impression of a fake product that is not as good as the original. For the acceptance of a substitute, it is important that the product responds to consumer needs, as described by Hoek et al (2011b), and that the product has a high degree of similarity to the original product since that will always be seen as a reference by consumers. A highly valued product like meat leads to strong sensory expectations (Graça *et al*, 2015; Font i Furnols and Guerrero, 2014). A contrast effect after high disconfirmation of expectations could lead to lower acceptance of a new product (Cardello, 2007). It could be that expectations are still not met when consuming a meat substitute, since the taste and texture are still too different from meat. The question remains whether improved sensory properties will further increase

consumer acceptance of meat substitutes, or whether the image of being artificial and fake will stay an obstacle.

Consumer-related factors and meat substitutes acceptance

All the respondents in the described studies had some experience with meat substitutes. We found that respondents who were more familiar with meat substitutes, as reflected in a higher usage frequency of meat substitutes, tended to give higher appropriateness ratings to meat substitutes in a meal context or a situational context (Chapters 3 and 5). Furthermore, higher meat consumption frequency was related to lower appropriateness ratings of meat substitutes (Chapter 5). Familiarity has also been shown to increase usage versatility, i.e., the number of appropriate usage situations, in other foods (Giacalone & Jaeger, 2016). It could be that expectations regarding the sensory properties of meat substitutes change after repeated exposure to these products. Besides, consumers might have tried meat substitutes some years ago and were disappointed with the taste, but became more positive about them after trying the newer generation of meat substitutes that resemble the properties of meat more closely and/or have better sensory properties. Another factor could be that the more familiar consumers get with the way meat substitutes can be used in a dish, the more confidence they have in the appropriateness of meat substitutes in different usage situations (Elzerman et al, 2021). Uncertainty about the sensory experience and the preparation of a meal without meat or with meat substitutes was also often mentioned in a qualitative study by Collier *et al* (2021). Their focus groups among Swedish consumers also showed that consumers expressed some skepticism about the need for meat substitutes or the reduction of meat consumption. This could indicate that not all consumers are aware or want to acknowledge the influence of their behavior on the environment.

Consumers vary in their attitudes towards meat substitutes and meat. We found that younger consumers and women were more positive about the appropriateness of meat substitutes, as were persons with a low Food Neophobia Score (Chapters 3 and 5). This is in line with several other consumer studies on meat substitutes (Hoek et al, 2011a; Siegrist & Hartmann, 2019; Bryant et al, 2019). The effect of gender was also recognized in a review by Onwezen et al (2021), who concluded that the acceptance of plant-based meat substitutes was lower by men than by women. A reason for this can be that meat-eating is often associated with masculinity, which poses a barrier to the adoption of meat substitutes (Schösler, de Boer, Boersema & Aiking, 2015; Jahn, Furchheim and Strässner, 2021). An explanation for the effect of age can be that younger generations have less strict norms than older consumers do and that the norms towards eating meat might have shifted over time (Jahn *et al*, 2021).

Contextual factors influencing meat substitute acceptance: meals and situations

In the various studies, we showed how the context in which meat substitutes are eaten affects consumer responses to these products (such as liking, appropriateness, and use-intention). Meat substitutes differed in their appropriateness for use in different contexts. We found evidence that appropriateness and meal context play a role in the acceptance of meat substitutes: different types of meat substitutes did not fit equally well in the different dishes. This difference in perceived appropriateness was first found in the online survey showing photographs of meat substitutes alone and meals with meat substitutes (Chapter 3) and confirmed in the Central Location Test with consumers tasting the meat substitutes and the meals (Chapter 4). The findings showed that there should be a compatible combination of meat substitutes and meals and that the shape of the meat substitutes plays a role in this. Shapes that differed too much from the meat product that was often used in a certain dish received lower appropriateness ratings from consumers than the more common meat shapes for that meal, resulting also in lower use-intention ratings. Also, the role of the flavor and texture of meat substitutes seems to depend on whether these products are eaten in a meal context or not. Some differences in liking of the individual meat substitutes (mince or pieces) were reflected in the overall liking of the meals, and others were not (Chapter 4). This could be explained by the masking effect of the other ingredients of the dish (e.g., a sauce), resulting in the reduced perception of the flavors and textures of meat substitutes themselves. Therefore, the flavor and texture of the individual meat substitutes might be less important when eaten in a meal context. It could also be that some flavors and textures influence each other or are more congruent than others. There is a growing interest by researchers wanting to put their finger on 'food pairing', i.e., the concept that some food combinations are more compatible than others. However, no strong sensory foundation has yet been found for food pairing (Lahne, 2019). Other research on contextual interactions showed that flavor perception is influenced by the presence of other foods (Cardello, 2019). This type of research was mainly performed on more simple food combinations, such as drinks, and just one or a few sensory attributes, such as sweetness or bitterness.

Usage situation is another important factor in consumer acceptance of meat substitutes. The consumer surveys in 2004 and 2019 showed that meat substitutes were not found as appropriate as meat in most usage situations and the perceived appropriateness of meat substitutes differed among the usage situations (Chapter 5). Meat substitutes were perceived as products that are appropriate in 'ordinary meals' when not much time and effort was spent on the preparation of the meal, although common meat products were found more appropriate. This is in line with Michel *et al* (2021) who concluded in a study on self-appointed omnivores and flexitarians that meat substitutes were considered more appropriate when eating alone, or with the family on a weekday. They suggested that meat substitutes might only be appropriate for eating occasions with less peer pressure, indicating that consumers might be somewhat embarrassed about their choice of a meat substitute. Consumers find meat substitutes also not appropriate for special occasions, a dinner with friends, or for

making the dish tasty, which also became clear from the in-depth interviews (Chapter 6). Strikingly, meat alternatives like chickpeas and especially nuts seem more appropriate products for these occasions. An explanation for this could be that these products are perceived as more natural products since they have undergone minimal processing. Meat substitutes, on the other hand, have undergone many processing steps to make them resemble meat, and are therefore perceived as less natural (Varela *et al*, 2022). This can cause a clashing combination of product qualities, less natural and more convenient, resulting in products that are not considered candidates for formal occasions, such as a Christmas dinner, as was also put forward in the in-depth interviews.

In conclusion, both the meal context and the situational context seem to play an important role in the acceptance of meat substitutes.

7.4   Methodological considerations

This research used a variety of qualitative and quantitative methods including focus group discussions, semi-structured in-depth interviews, web-based surveys, a Central Location Test with meat substitutes and meals, and a descriptive study. These different methods generated different types of insights, an approach that is advised for consumer-oriented product design (Sijtsema, 2003). However, in the methods we used, consumers were asked to express their thoughts or give a rating to their opinion on acceptance or appropriateness. The principle behind this self-reported perception is that consumers make rational choices, but in reality, this is not always the case (Köster, 2003). Besides, although a quick way to reach a large group of respondents and to ask many questions, a survey with photographs of products and/or meals is a different experience than the actual eating of the food, which can affect the validity of the test (Köster, 2003). This is less of a problem with a Central Location Test, where samples of meals with meat substitutes were tasted in a university dining room. However, the presentation of multiple samples of meals per session is of course different than how consumers would experience a meal with meat substitutes at home or in a restaurant. Also, the meals were relatively simple.

Furthermore, the studies in this thesis worked with commercially available meat substitutes, both for the photographs in the various studies as well as in the Central Location Test. On a positive note, products could look (somewhat) familiar, but a drawback is that some products differed in multiple aspects and sensory properties could not all be varied in a controlled way.

Another methodological consideration is that most respondents that participated in our research knew that they took part in a study on meat substitutes, therefore might have been more interested and familiar with meat substitutes. The convenience samples that were used were not representative samples of the Dutch population, so our results might not give a complete reflection of the Dutch population. To be able to generalize for the Western world, this research should be repeated in other countries. Consumers in Western countries do not

always respond in the same way regarding meat reduction and meat alternatives (Weinrich, 2018), but to what extent this translates into different consumer behavior is not yet clear.

7.5   Recommendations

Recommendations for further research

An abundance of research has been conducted on consumer acceptance of meat substitutes over the last decade. However, what product properties are the main drivers for the consumption of meat substitutes has still not been fully elucidated. Although the texture and flavor of meat substitutes have improved greatly over the last years, the sensory perception of meat substitutes remains a point of concern (Vermeulen, 2020). It is important to distinguish between meat substitutes that are meant as 'separate meal component', such as vegetarian burgers, schnitzels, or steaks, that take a central role in a dish, and meat substitutes that are used as an ingredient in a dish, such as mince or stir-fry pieces. The importance of sensory properties seems to be different for these two categories. Mainly for the meat substitute ingredients, meal context should be part of the sensory and consumer studies. Very little research has been done on how flavors and textures of meat substitutes match together with other ingredients of a dish. To what extent this harmony of meal ingredients plays a role would be a question for future research.

There is also still more to learn about the situational appropriateness of meat substitutes. One question that has not been fully answered is why meat substitutes are mainly found appropriate in ordinary usage situations, such as on a normal weekday, but not for special occasions (e.g., a celebration). Technological advances make it possible to study consumer responses to a situational context in different ways. Most of the available research on context, and consumer acceptance in general, has been conducted by making use of surveys, where consumers report on their behavior or expected behavior. With new technologies, there are now multiple options for studying food products in natural settings or immersive environments, such as virtual reality, evoked contexts, etc. (Hartmann& Siegrist, 2019; Lichters, Möslein, Sarstedt, and Scharf, 2021). These are promising methods that come closer to real-life settings which can increase the validity of the study.

Also, this thesis focused on Dutch consumers. However, the environmental burden of meat consumption and the acceptance of meat alternatives are global issues. Although studies on consumers' perception of meat alternatives in different countries are being published over the last years, little is known about the appropriateness of meat substitutes in other countries. Future research could compare the appropriateness and consumer motives behind this in different countries to get a better insight into cultural factors.

From the perspective of understanding consumers, we tried to characterize our respondents by inquiring about demographic and consumption data and some character traits. However,

this did not give insight into how the process of acceptance of meat substitutes comes about. Research on why some consumers reject these products and what is needed for them to retry them, as well as insight into how to increase the usage frequency of meat substitutes is needed. Ultimately, future research should focus on what different types of consumers need to become more open to a lifestyle with less meat consumption.

Recommendations for product development of meat substitutes

Product development of new meat substitutes could improve the composition of meat substitutes to make healthier and less processed products. The newer, second-generation meat substitutes have a similar protein content as meat but can be classified by the NOVA Food Qualification system as ultra-processed foods and contain more saturated fat and additives such as salt than meat (De Jong, 2021; Penna Franca, Duque-Estrada, da Fonseca e Sá, van der Goot, and Pierucci (2022). Nutritional aspects, such as the protein, fat, and salt content should be focus points for product development of meat substitutes, as the consumer perception of these product properties is not always good. The consumer trend of 'clean label' underlines that consumers nowadays prefer products with fewer additives and more transparency about the ingredients and the supply chain of the products (Askew, 2021).

The sensory properties of meat substitutes can still be enhanced as well, however, the focus for product developers should be on the match of different meal components (form, flavor, and texture). Packages could inform consumers better on possible usage situations and preparations, as some consumers are unsure about how to prepare a meal with meat substitutes. Furthermore, place and visibility in the stores could enhance the sales of meat substitutes. For some consumers, it could be better to place meat substitutes next to their meat equivalents, to remind them of the option of a vegetarian alternative (Vandenbroele *et al*, 2021). Moreover, products that are targeted for more luxurious situations could be developed. These products can be quite different from the existing meat substitutes (e.g., vegetarian oven-ready meal kits with butternut squash or mushrooms that are sold in the supermarkets around Christmas time). As meat alternatives like pulses and nuts were overall rated quite high on situational appropriateness, these products could also contribute to the reduction of meat consumption. Less processed products, that do not necessarily resemble meat could be good alternatives for consumers who are more familiar with the vegetarian lifestyle.

Products should be targeted to different consumer groups, as they seem to have different wishes and expectations regarding meat reduction. Whereas consumers who have an (almost) vegetarian lifestyle generally prefer products that have no resemblance to meat, meat-eaters often like to have a meat-like product on their plates. For consumers who are reluctant to reduce their meat consumption, hybrid products, consisting of partly plant

proteins and meat, could be a good option (Bancovic, 2022). These products should be well-positioned in the market, with a focus on sensory perception, health, and versatility

Recommendations for policymakers

In countries like the Netherlands, where until recently meat was the center of the meal, the reduction of meat consumption by the general public is a slow process. Slowly but surely, more consumers are aware of the environmental issues involved with meat production. Policy could be designed in such a way that a transition to a merely plant-based diet is facilitated. Different approaches to policy design have been proposed. For example, de Boer and Aiking (2017) underline the importance of the role of frames (i.e., knowledge structures that capture specific features of a food or meal) in consumer behavior. They propose a frame-based approach to 'assist consumers on the path to a healthy and sustainable low meat diet'. For example, when existing frames (about eating meat, what is a meal, and what is healthy and sustainable food) are better understood, new frames that offer a moderate amount of novelty (e.g., recipes or products) can be developed that build on the familiar culinary principles of variety, balance, and moderation. These 'bridging frames' may enable consumers' interpretation of the health and sustainability benefits of plant-based proteins.

Another approach for more effective policy and intervention design is the Behaviour Change Wheel (Michie, van Stralen and West, 2011). Three essential conditions in behavior: capability, opportunity, and motivation, form the basis of this method and there are usually multiple policy levers that can be used to optimize these conditions. For example, the Dutch dietary guidelines advise reducing meat consumption for a healthier and more sustainable diet. Interventions to implement this could be through increasing knowledge (capability) by education on nutrition and sustainable food production in primary and secondary schools, while training of skills (e.g., cooking) will increase consumers' opportunity, and making use of role models can motivate consumers to start a sustainable lifestyle. Better knowledge of consumers on the importance of food technology and food processing could also help them make a fairer comparison between meat and meat substitutes and enhance the acceptance of meat substitutes. Furthermore, government campaigns on nutrition, climate, and meat reduction could create more familiarity with meat reduction and alternatives. Another policy tool is through communication and marketing of the desired behavior, such as communicating the benefits of a sustainable lifestyle and a diet low in meat. Rather counterproductive in this sense, is the promotion of meat consumption by the European Commission (Sanchez Nicolas, 2021).

Consumers' capability toward a diet change could be increased by 'environmental restructuring' by making the sustainable choice the easy choice. 'Nudges', such as improving the visibility of meat substitutes and making plant-based meals the default in campaigns,

could steer consumers toward more sustainable food choices (Lehner, Mont, and Heiskanen, 2016; de Ridder, Kroese, van Gestel, 2021; Vandenbroele *et al*, 2021).

Lastly, coercion through fiscal measures and legislation could enhance the transition process by reflecting the environmental impact of the production of foods in the prices of the products (e.g., meat tax), making meat alternatives more attractive to consumers.

7.6   Main conclusions

The research presented in this thesis studied consumer acceptance of meat substitutes from the unique perspective of context (meal context, usage situation). It contributes to a better understanding of what is needed for meat reduction, further improvement of meat substitutes, and the role that contextual factors play in this.

Consumer motives given for reducing meat are mainly health, animal welfare, and environmental reasons. When meat substitutes are chosen it is to take over the role of meat in the dish, but also to not miss out on important nutrients. Meat substitutes are mostly perceived as convenient and healthy products, although their highly processed image may adversely affect consumer acceptance. Their sensory properties also still need attention to win over more consumers. How important the sensory properties of meat substitutes are will depend on the type of dish they are used in. When used as ingredients in a dish, the meal context affects the acceptance of meat substitutes, and the sensory properties (appearance, taste, and texture) influence their appropriateness in a meal. This important role of context was also found for situational context: meat substitutes are perceived as appropriate in ordinary eating situations, not for special occasions. Their convenience is praised, but the identity of a fake and imitation product negatively affects consumer acceptance. Different consumer groups with respect to age, gender, and consumption frequency of meat substitutes and meat ask for different approaches and products. Consumers who are more familiar with meat substitutes, as well as women and younger consumers are open to both meat substitutes and other meat alternatives (like pulses and nuts), but for less familiar, older consumers and men, meat substitutes should be further improved and dishes in which these products are less prominent seem more successful.

For a transition toward a more plant-based diet, the wider public should become more aware of the need to reduce meat consumption as well as become more familiar with meat substitutes and other meat alternatives.

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Summary

Summary

The environmental pressure caused by meat production together with the growth of global meat production and consumption necessitates a shift in our dietary behavior from an animal-based diet to a more plant-based diet. An alternative for meat could be plant-based meat substitutes since meat substitutes can have a lower environmental impact than meat. Despite the growth of the market of meat substitutes, the adoption of these products by consumers is a slow process. Not only the properties of the product itself but also contextual factors (e.g., the usage situation or the meal) could influence consumer acceptance of meat substitutes.

The overall aim of this thesis was to identify the roles of the product, the context, and consumer characteristics in the acceptance of meat substitutes.

Chapter 1, the general introduction, describes the problem definition, including background information on meat consumption, meat substitutes, as well as food acceptance, and the role of context and appropriateness. This chapter ends with the rationale and outline of this thesis.

Chapter 2 explores the experiences and perceptions that consumers had of meat substitutes. Consumer focus group discussions revealed that health aspects and easy preparation were regarded as positive aspects of meat substitutes, whereas lack of information on the package, and high price were reported as negative. Sensory attributes such as neutral taste or tastiness, crispiness, chicken-like texture, or granular texture were seen as positive attributes. Sensory attributes that were mentioned as negative were a uniform taste, compactness, dryness, and softness. When photographs of examples of meals with meat substitutes were presented, then most consumers found the use of meat substitutes appropriate in those dishes.

Chapter 3 describes a web-based survey on the appropriateness, attractiveness, use-intention, and (un)desirable sensory properties of meat substitutes in different dishes based only on visual information. A questionnaire was developed to let consumers assess the use of meat substitutes in different dishes. The survey consisted of 38 key questions with subdivisions and was completed by 251 respondents. Six different dishes (spaghetti, rice, wrap, pizza, pasta salad, and soup) were rated for their appropriateness for the use of meat substitutes. Subsequently, appropriateness, attractiveness, and use-intention were rated based on photographs of the six dishes prepared with meat substitutes that differed in shape and appearance. Respondents also had to indicate (un)desirable sensory properties of meat substitutes for every dish. Spaghetti, rice, and wrap were found more appropriate for the use of meat substitutes than the other dishes. The most appropriate meat substitute–meal combinations were those that are similar to common Dutch meal combinations (e.g., spaghetti with mince and rice with pieces). Attractiveness and intention scores were in line with the appropriateness scores. Furthermore, we found that users of meat substitutes and younger respondents gave higher appropriateness ratings. This study demonstrated that the appropriateness of meat substitutes in a dish is related to attractiveness and use intention.

Chapter 4 describes a study that investigated the role of meal context on the acceptance of meat substitutes in a central location test. A total of 93 participants rated meals with meat substitutes on overall liking, product liking (liking of the meat substitute in the meal), appropriateness and intention-to-use, and individual meat substitutes were rated on overall liking. Meat substitutes with similar flavor and texture, but with different shapes (pieces and mince), were rated differently in four meals (rice, spaghetti, soup, and salad) on product liking, appropriateness, and intention-to-use, but not differently on overall liking of the meals. Meat substitutes with similar shapes, but different flavors and textures rated differently on overall liking when tasted separately, but did not always differ in product liking when tasted in a rice meal. Appropriateness seemed to be influenced by the appearance of the meat substitute-meal combination, and less by the experienced flavor and texture.

Chapter 5 describes the study on perceived situational appropriateness of meat, meat substitutes, and other meat alternatives in different usage situations using an item-by-use appropriateness survey. Products were presented via photographs and for each combination of product and situation, the appropriateness was rated on a 7-point scale. Personal information included the consumption of meat and meat substitutes and Food Neophobia. An exploratory survey was conducted in 2004 and an online survey in 2019. Overall, meat products were perceived as more appropriate than their vegetarian equivalents (e.g., hamburger vs. vegetarian hamburger) in almost all situations. Meat alternatives (chickpeas, nuts) scored generally higher than meat substitutes on situational appropriateness. Age and gender affected appropriateness ratings: women and younger respondents gave higher ratings to meat substitutes and meat alternatives. Food Neophobia showed a small effect. Meat substitute consumption frequency was a predictor of overall appropriateness in 2019, whereas it was not in 2004.

Chapter 6 describes in-depth interviews aimed at understanding consumers' associations with vegetarian eating and meat substitutes and their motives regarding the situational appropriateness of meat substitutes. Twenty in-depth interviews were performed to discover associations of Dutch current users of meat substitutes with the terms 'eating vegetarian' and 'meat substitutes'. Furthermore, their motives for the appropriateness of the use of four meat substitutes in six different usage situations were investigated. The meat substitutes (vegetarian minced meat, vegetarian hamburger, vegetarian steak, and vegetarian stir-fry pieces) were presented as photographs and the usage situations (e.g., eating with family, having little time to cook) were described and the participants were asked to express why the meat substitutes were (in)appropriate in the usage situations. The term 'Eating vegetarian' was mostly associated with 'no meat' and 'alternative protein foods' and the most mentioned motive for eating vegetarian was 'environmental impact', followed by 'health' and 'animal welfare'. 'Meat substitutes' were mostly associated with 'specific meat substituting products' and the most mentioned motives were 'nutrient substitution' and 'traditional meat replacement'. Most participants perceived vegetarian stir-fry pieces as appropriate for almost all situations. The thematic content analysis yielded seven categories for the motives given

for the (in)appropriateness of the four meat substitutes in six usage situations: 'functionality', 'convenience', 'properties', 'preferences', 'association with meat', 'association with meals', and 'nutrition'. Mainly motives in the categories convenience and functionality (function of the meat substitute in a meal) were mentioned for all situations and other motives were situation-specific.

Finally, *Chapter 7*, the general discussion of this thesis, reflects on the methodological considerations, the main findings, their implications, and gives recommendations for further research, product development, and policy. Meat substitutes could become successful alternatives to meat, as they are perceived as convenient and versatile products. Meal context should play a central role in the design of new meat substitutes, as the combination of the meat substitute and the meal, and not so much the meat substitute itself, determines the acceptance of these products. Situational context plays a role as well; e.g, meat substitutes are perceived as appropriate for a dinner at home with the family, but not for special occasions. Challenges that need to be faced are the dual image of meat substitutes being plant-based, healthy and low fat on the one hand, and unnatural and fake on the other hand. Consumer acceptance and appropriateness of meat substitutes is still lower than that of meat, but increasing their familiarity could help overcome this issue and pave the way for a successful societal shift toward a mostly plant-based diet.

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About the author

About the author

Hanneke Elzerman (1971) was born and raised in Arnhem, the Netherlands, where she attended the Christelijk Lyceum Arnhem. She then chose to study Food Technology at Wageningen University, but switched one year later to Human Nutrition, in which she obtained an MSc degree in 1996 in the specialization Nutrition, Food and Toxicology. Internships were at the Netherlands Nutrition Center and the Human Nutrition Unit of the University of Sydney, Australia, whereas thesis projects were on nephrotoxicity of anti-oxidants (department of Toxicology, Wageningen University), and plant sterols in parenteral nutrition (Department of gastrointestinal and liver diseases, Radboud Hospital, Nijmegen).

Hanneke then worked on understanding the folate metabolism at the Human Nutrition Research Center on Aging at Tufts University (Boston, USA) in 1997/ 1998, after which she worked on 'weaning foods' at Numico Research in Wageningen. In November 1999, this PhD journey started at the group that is now called 'Food Quality and Design'. The research was part of the multidisciplinary research program 'PROFETAS', Protein Foods, Environment, Technology and Society, a very progressive research program at the time, that studied the options for more sustainable food production and consumption, through the replacement of meat consumption by plant-based meat substitutes. Hanneke focused on consumers' (sensory) preferences and the role of contextual factors.

After a research position in sensory and consumer research at Top Institute Food and Nutrition (Wageningen) in 2005/ 2006, Hanneke decided to spend most of her time on raising her children, before starting her current job in 2016 as a lecturer at the Food Technology group at van Hall Larenstein University of Applied Sciences in Velp, the Netherlands. In September 2019 she continued her PhD research with two new studies on consumer acceptance of meat substitutes.

Hanneke's main passions are nature and traveling. She lives with her husband and her two sons in Velp and can be contacted by email: hanneke_elzerman@yahoo.com.

Overview of completed training activities

Discipline specific activities

- Course on sensory evaluation techniques, Sensory Spectrum, USA, 2000

- Course on multivariate analysis, CAMO, Germany, 2001

- Course: 'Targeting the Consumer', Hal MacFie, UK, 2004

- 'Kwaliteit van voedsel: ethische en esthetische aspecten', WUR, 2003

- Pangborn Sensory Science Symposium, France,   2001

- Profetas symposium, WUR, 2004

- European Conference on Sensory Science of Food and Beverages, Italy, 2004

- European Conference on Sensory Science of Food and Beverages, online, 2020

- Symposium joint meeting BFDG and WEVO, NL, 2005

- Mini-symposium 'Will novel protein foods beat meat?, WUR, 2010

General courses

- VLAG PhD week, WUR, 2000

- Scientific Writing/English Grammar, WUR, 2000

- Basiskwalificatie Didactische bekwaamheid en Basiskennis Examinering, HAN, NL, 2019/2020

Optional courses and activities

- Preparing PhD research proposal, WUR, 2000

- PhD tour, Denmark and Sweden, 2000

- Symposium 'Proeven van succes I', NL, 2002

- Symposium 'Proeven van succes II', NL, 2005

- Food valley summit 'Proteins of the future', NL, 2018

- Symposium MOA Profgroup, NL, 2018

- Food Trend College Ultraprocessed Foods, HAS Den Bosch, 2019