FQD80436 - MSc Thesis Food Quality and Design:Factors affecting (young) adolescents' (15-24 years old) acceptance of plant-based meat alternatives in the Netherlands.



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Abstract

The awareness of adopting more plant-based meat alternatives has been the center of discussion for ages and in the past few years major changes have been observed in people's food choices, especially in Europe. This research explores the influence of knowledge, familiarity, and cooking skills on the acceptance of plant-based meat alternatives among adolescents aged 15-24 in the Netherlands. Adolescents were selected as the focus of this research due to several factors: their heightened awareness, susceptibility to influence from peers and family, significant role in societal changes, and increasing autonomy, often associated with financial independence, enabling them to make dietary decisions autonomously. With the rising interest in sustainable diets, understanding factors that shape acceptance of plant-based options is vital. Through questionnaire, interviews and experimental interventions, we assess how individuals' understanding of plant-based diets, familiarity with alternative sources to meat, and culinary expertise impact their attitudes toward both natural and traditionally processed meat alternatives. Additionally, we investigate the efficacy of intervention methods, such as providing knowledge cards and cooking classes, in fostering positive acceptance. By analyzing data through thematic analysis from a diverse sample, this study aims to provide insights into effective strategies for promoting the adoption of plant-based diets among young individuals. Findings will contribute to the development of targeted interventions and policies to encourage food choices replacing meat with natural plant-based meat alternatives in the Netherlands and beyond.

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1. Introduction

Problem definition

Awareness of plant-based diet has been observed in recent times and reports have suggested that a shift from meat to plant-based foods is not only beneficial to humans but is also planet-friendly (Gibbs & Cappuccio, 2022; Poore & Nemecek, 2018) and has been a topic of discussion for decades (Ishaq et al., 2022). In line with this, numerous new plant-based alternatives to conventional meat-based foods and diets are being introduced. Understanding the context and reasons of consumers for adopting these items has crucial implications for marketing positioning, message, and promotion. It also has an impact on the environment, animals and mainly also on the human health.

As per a survey done in the Netherlands, the vegetarian population reached 11% in 2021 and in 2018 specifically it was observed that age groups between 18-24 years following a vegetarian diet was five times as large as the share of respondents aged 55 years and older. The age groups 18-24 years and 25-34 years were also more among the flexitarian population. A 2019 survey also found that the main reason for people to go vegetarian was to include vairety in their meals which was better for nature, animals and for health although price didn't seem to be playing a major role. (Netherlands: Vegetarians and Flexitarians 2022 | Statista, 2022)

The average consumption of meat has fallen by 18% in the Netherlands for 7–69-year-olds in recent years. In 2007-2010 this was 110 g/day, in 2012-2016 it was 101 g/day and in 2019-2021 it was 91 g/day. The average consumption of unsalted nuts and seeds increased from 3g/day in 2012-2016 to 5g/day in 2019-2021. The number of days per week of legume consumption was seen to be 0.4 days per week in 2019-2021 but there was hardly any increase in vegetable protein consumption although it was interesting to observe 42- 48% among the consumers were girls in the age group 7-17 (*Dutch People Eat More Healthy Foods: More Plant Products, Less Red and Processed Meat / RIVM*, 2023.) The Dutch government has set a target of reducing animal protein consumption by at least 20% by 2030 (RLI, 2018).

When it comes to the health aspect of transitioning from meat to plant-based food, there have been various researches done that report the harmful impact of animal foods on the body. Obesity, particularly enormous obesity, is becoming increasingly common among youngsters. Dietary considerations, along with other components of lifestyle, appear to be important in this tendency (Rizkalla et al., 2002). High levels of red meat consumption have been reported to be carcinogenic by WHO (World Health Organisation,2015) and also lead to various diseases like cardiovascular disease, obesity, and type 1 diabetes mellitus (Rizzo et al., 2023).

Research has also shown that the composition of livestock diets and the quantity of livestock are the primary determinants of greenhouse gas emissions (GHGE)(Poore and Nemecek 2018; Theurl et al. 2020). Diets that are rich in plant-based foods, such as vegan or vegetarian diets, have been found to have the lowest carbon footprint, as well as lower water and land use (Chai et al. 2019; Rabès et al. 2020). A report from The Ministry of Foreign Affairs, Netherlands on 'Plant-based & alternative Protein Sector & Midwest Region Analysis',2021, shows that out of the 15% anthropogenic (human-caused) greenhouse gas emissions, 40% comes from beef and dairy farming. The land used for livestock needs to be taken into consideration as it cannot be used for other crops.

Young consumers, particularly millenials born between 1980-2000 and beyond are leading in market demand for more plant-based foods (Rowland, 2018), and it is expected that an increase in consumption of plant-based alternatives will be observed by understanding the younger population.

One research of former meat avoiders found that the complexity of cooking new meals was a significant obstacle to continuing a plant-based diet (Haverstock & Forgays, 2012). Similarly, research with meateating consumers highlighted a lack of information as well as a lack of culinary skills as barriers to adopting plant-based diets (Hoek, Pearson, James, Lawrence, & Friel, 2017; Lea, Crawford, & Worsley, 2006b, 2006a; Mullee et al., 2017; O'Keefe et al., 2016).

On the other hand, according to the survey on Europeans (*Plant-based Foods in Europe: What Do Consumers Want? - Smart Protein Project*, 2021) 37% of the participants were flexitarians, vegetarians, or vegans, which indicated a reduction in animal-based foods or even completely excluding meat from the diet and a transition to plant-based food being the new normal. Most vegetarians had adapted their diet for over five years while the flexitarians and vegans had chosen a plant-based diet for six months to two years and some even five years. A shift to a plant-based diet is a long-term process that is most likely to succeed when it does not drastically differ from the customers' previous behavior. The usage of meat alternatives is expected to facilitate this shift, particularly among non-vegetarian customers.

According to a study from smartproteinproject (*Plant-based Foods in Europe: What Do Consumers Want?* - *Smart Protein Project*, 2021), the younger generations (Generation Z and Millenials) who are conscious of their health and environment friendly food choices, source most of their information from google, nutritio-society websites, and social media platforms to learn about plant-based foods.

Research gap

According to research conducted by (Havermans et al., (2021b), in the Dutch Province of Limburg among adolescents, education on plant-based diet, by increasing awareness and researching on the skills to prepare plant-based meal could lead to a better understanding, familiarity and acceptance of plant-based alternatives. Another study (Davitt et al., 2021) also showed that providing knowledge through education could help improve acceptance of novelty of plant-based alternative. There are multiple definitions of what plant-based meat alternatives mean but here we stick with defining them as plant-derived alternatives which are unprocessed whole foods such as lentils, beans, mushrooms, nuts, and processed traditional foods such as tofu, seitan, and tempeh (Verain et al., 2015; Andreani et al., 2023; "Meat Protein Alternatives," 2022). The focus of the study is not only on plant-protein alternatives but on plant-based alternatives to meat in the main meal. Since not a lot of study specifically defines natural PBMA, the above definition was found more suitable.

Since there is gap in the previous studies, the aim is to understand the factors affecting adolescents' acceptance of natural and traditionally processed plant-based meat alternatives in the Netherlands. Thus, the research question is: What are the factors affecting (young) adolescents' (13-24 years old) acceptance of plant-based meat alternatives (natural and traditionally processed) in the Netherlands? The sub-research questions for in-depth analysis of the main aim are:

- 1. What is the influence of **product knowledge and skills on acceptance** of plant-based meat alternatives (PBMA) by adolescents and young adults in the Netherlands?
- 2. What is the influence of **product familiarity on acceptance** of plant-based meat alternatives by adolescents and young adults in the Netherlands?

2. Theoretical Background

2.1 Plant-based meat alternatives (PBMA): types, benefits, and barriers

Only 19 of the 91-research reviewed by Onwezen et al. (2021) involved pulses or plant-based meat substitutes, and only a few of them explicitly compared meat alternatives to meat. Bakhsh et al. (2021) mentions soy protein, wheat gluten, bean flour, and nuts as excellent meat alternatives, producing taste and texture like meat. In the recent times, plant-derived materials have been preferred over animal counterparts due to lower incidence of infection and contamination, lesser limitations when it comes to cultural and religious habits, their versatility, and lower costs (Jafari et al., 2020; Nasrabadi et al., 2019). To promote human health and environmental sustainability, dietary patterns rich in minimally processed fruits, vegetables, whole grains, nuts, soy, and other legumes have been advocated (Hu et al., 2019). According to Elzerman et al. (2021) research on the appropriateness of meat products, meat replacements, and meat alternatives in various use settings, plant-based alternatives are perceived as healthier, while meat is seen as more enjoyable, tastier, and more celebratory. The majority of consumer research has concentrated on the frequency of legume intake or the preference for increased legume quantities in meat meals (Jallinoja et al., 2016b; Spencer et al., 2018). Furthermore, previous research focused on consumers' readiness to cut meat intake, whereas Lemken et al. (2019) focused on the shift from meat to legumes.

Grain legumes combined with whole grain cereals can substitute meat as a source of protein, zinc, and iron while also raising fiber and folate consumption above the typically low levels in Western diets (Röös et al., 2018). Grain legume consumption has been shown to provide benefits like prevention and treatment of chronic diseases, including type 2 diabetes, cardiovascular diseases, obesity, inflammatory diseases and cancer (Clemente & Olias, 2017). Grain legume cultivation also enhances cropping systems since legumes may fix nitrogen and function as a break crop in cereal-based systems (Röös et al. 2019). In Western diets, lightly processed legumes (soaked and boiled) might be regarded as a vegetable rather than a protein part of a main meal, but meat replacements are true 'meat replacers' in how they operate in meals. (De Boer & Aiking, 2019; Van Der Weele et al., 2019). Common hurdles to legume intake described in the literature include poor taste, discomfort, and a lack of knowledge of and abilities in the preparation of legumes (Hoek et al. 2011; Jallinoja et al. 2016; Niva et al. 2017, pp. 157–171; Schyver & Smith, 2005; Schösler et al. 2012; Wenrich & Cason, 2004; Weinrich, 2018; Melendrez-Ruiz et al. 2019; Collier et al. 2021).

Mushrooms because of their high protein content (19-40% on a dry basis), dietary fiber, umami flavour, and fibrous texture, have been used to replace meat products (Rangel-Vargas et al., 2021). Tempeh and Tofu items made from soybeans are well-known plant-based meat substitutes. Tofu is a popular plant-based food in many countries, including Korea, India, America, Australia, Cambodia, China, Europe, Indonesia, Japan, Malaysia, Myanmar, New Zealand, the Philippines, Singapore, Thailand, and Vietnam (Pal et al. 2019).

Various plant proteins, including wheat gluten, are also used in traditional meals like seitan (Kyriakopoulou et al., Dekkers et al., and Goot et al, 2019).

2.2 Adolescents as a target group

Several psychosocial factors play a role in adolescents' eating behavior, especially in the social context of a school (Reinders et al., 2012). One of the studies says that Dutch adolescents by the age of 15 or 16 have a job outside of school hours which gives them an even bigger opportunity for individual food choices. (Havermans et al., 2021a). Once children move to adolescence, consumption of unhealthy food increases (Albani et al., 2017; Winpenny et al., 2017; Lytle et al., 2000) and this is a concern because this eating

behavior tracks into adulthood (Hu et al., 2016; Cruz et al., 2018) as well. Even during pre-adolescence (aged 10-14 years), they start making their food choices based on time and location, and the school environment setting is one of the prime locations (Banna et al., 2020; Reicks et al., 2015; Sawyer et al., 2012). This theory could be applied to adolescents' eating choices and behavior and why it is important to study this age group.

2.3 Diversity among adolescent population and their eating habits

Of the 17.6 million people (about the population of New York) residing in the Netherlands on 1 January 2022, 2.6 million were born abroad. They came to the Netherlands as migrants. The study on 18-35-yearold participants (De Boer et al., 2017) was part of a larger initiative to determine how young adults in the Netherlands might help promote healthier and more sustainable food choices while taking into account the multiethnic nature of future populations. They concentrated on the second generation of migrants, defined as young Dutch individuals with at least one parent born abroad, to highlight the multicultural dimension. The Chinese Dutch (hereinafter referred to as Chinese) and Turkish Dutch (hence referred to as Turkish) migrants were identified as two significant new ethnic groupings. For the sake of clarity, the other Dutch adults were referred to as native Dutch. It should be emphasized that Dutch cuisine is quite basic, although there are several ways to cook meals without using animal-based products, such as by utilizing meat substitutes. Foods in Chinese and Turkish cuisine may be regarded as meat alternatives due to their protein content, although they may also be used with meat. This is true of tofu, a prominent ingredient in Chinese cookery, as well as the numerous types of legumes used in Turkish cooking (De Boer et al., 2017). Only one study explored the relationship between cultural background and people's willingness to reduce meat consumption directly. Results of this study comparing people of different ethnic backgrounds (Schosler et al., 2015) suggest that second-generation Turkish migrants of both genders were much less likely to reduce meat consumption compared with Chinese or Dutch people. This result also suggested that there are large cultural differences about people's willingness to reduce meat consumption. The impact of sociodemographic variables other than gender or cultural background has rarely been examined.

2.4 Influence of cooking skills and knowledge on acceptance of plant-based meat alternatives

In most studies, lack of skills, knowledge and inspiration are among other factors leading to lower meat consumption. It is also reported that flexitarian participants were not completely informed of the benefits of nutritional values or about the vegetarian diet (Sijtsema et al., 2021; Hielkema and Lund, 2021; Pohjolainen et al., 2015; Reipurth et al., 2019). When the attributes were checked for consumer behavior towards plant-based meat, it was observed that one of the factors in person-related characteristics was the skill to prepare, which was a trade-off when choosing a meat substitute.

Cooking is one of the most valuable skills and is often developed at a very young age. It is linked to improving healthy food intake and for the prevention of diet-related non-communicable diseases. Not having the ability to cook and a dislike towards the skill is also linked to increasing levels of fast-food consumption. Especially among adolescents who cook or are involved in meal preparation for grocery shopping, have been shown to have a healthier diet. From the little research done, it is also shown that cultivating cooking during adolescence tracks to young adulthood and in turn better food choices (Lavelle et al., 2016). Cooking skills as defined by Wolfson et al., 2020, are organization and transformation of ingredients to produce a meal which includes skills related to the technical part of cooking which includes the ability to plan, cook, and deliver food within the food environment, time, and budget constraints.

Overall, meat consumption reduction options range from reduction to eradication (Lang, 2020). Reduction techniques include eating less meat and increasing the proportion of non-meat items ingested at mealtimes (e.g., vegetables) (Lang, 2020; Kemper & White, 2021). Partially substituting meat for non-meat protein sources in traditional meat-based recipes (e.g., replacing a portion of beef with mushrooms in hamburgers) or fully substituting meat for non-meat protein sources (e.g., replacing pork with black beans in tacos) (Lang, 2020; Kemper & White, 2021). Reduced meat portion size may be more achievable for many customers since it does not need any changes to the meal recipe or setting or the acquisition of new cooking skills. In contrast, depending on the degree of replacement, kind of non-meat protein source, and required cooking abilities to perform the dish, replacing meat with a non-meat protein source may be viable (Eckl et al., 2021). Mylan (2018) found that cooking, along with nutrition beliefs and sourcing helps with meat reduction in the meals. In qualitative research with 23 young people done in New Zealand, it was shown that participants who identified themselves as more confident and experienced in the kitchen swapped meat for plant-based proteins such as beans, lentils, and tofu. Although participants who identified themselves as less confident and skilled in the kitchen, on the other hand, opted to replace meat with more convenient, plant-based proteins such as vegetarian patties and sausages. Previous studies have also demonstrated that a significant obstacle to change is a lack of understanding regarding suitable meat replacements and how to prepare meals without meat (Tucker, 2014) which shows there is need to provide more cooking skills and information on plant proteins like in store or in community classes (Kemper & White, 2021b).

The positive effect of plant-based alternatives in terms of environment and potential health benefits has been observed in studies lately (Hu et al., 2019; Michel et al., 2021; Perez-Cueto et al., 2022; Santo et al., 2020). The intention to purchase a plant-based egg that contained soy protein concentrate and rice bran oil increased when more information was provided to the consumers about its benefits (Garcia et al., 2009).

Euromonitor,2020 found that Facebook, among other social media platforms, had the most reach and younger generations were influenced by Instagram and YouTube. As reported 60% of the respondents in Europe learned about plant-based foods from search engines like Google, and 50% from health and nutrition-society websites (*Plant-based Foods in Europe: What Do Consumers Want? - Smart Protein Project*, 2021). Almost 43% got their sources from food-company websites and the rest from online videos but the most trusted were nutrition and health-related websites and social networking sites were the least trusted, but they have proven to be influential among the younger generation as they give a feeling of community or mutual likelihood towards a particular topic

From a few studies conducted (Ensaff et al., 2015; Havermans et al., 2021a), it was identified that adolescents were unaware of the benefits and lacked knowledge of plant-based foods but the reasons for those who adapted a plant-based diet was still unknown. The level of knowledge they gained also had an influence and this was found to differ based on demographic and socioeconomic background (Fleming et al., 2020).Source and the quality of information have an influence on the consumption habit as it comes from various areas like families, friends, textbooks at school, social media or campaigns and this may sometimes be misleading or cause of conflict of interest. (Klassen et al., 2018,Qutteina et al., 2019,Lynch, 2010, Turner & Lefevre, 2017).

Almost half the Europeans stated that they need more information about plant-based foods. A lack of social interaction was also one of the reasons for reduced purchase or acceptance of meat alternatives. (*Plant-based Foods in Europe: What Do Consumers Want? - Smart Protein Project*, 2021. Younger persons were more likely than older people to mention a lack of knowledge as a barrier to lowering consumption (Lea et al., 2006).

The role of health-related benefits of plant-based meat has always been an area of concern and requires more research because consumers aren't aware of the full potential of adopting a plant-based diet or making choices that involve replacing meat.

2.5 Influence of familiarity on acceptance of plant-based meat alternatives

Consumers prefer items that are familiar in terms of flavor, look, and preparation over ones that are innovative. The urge to consume a food is highly influenced by familiarity with that cuisine. Plant-based meat recipes may be less favored since they are not yet universally viewed as familiar (Szejda et al., 2020). A survey from the smart protein project (Plant-based Foods in Europe: What Do Consumers Want? - Smart Protein Project, 2021) resulted in flexitarians reporting their preference for ingredients they are familiar with (potatoes and rice for example) when it came to plant-based-meat rather than tapioca, lupin, amaranth and other novel ingredients. According to Szejda et al. (2020), tradition and familiarity are factors that consumers consider to be crucial factors when selecting plant-based foods, especially traditional meat consumers for whom new replicas should match the meat products. A survey by Hoek et al. (2011) found that individuals generally avoid new foods and another study by Pohjolainen et al. (2015) shows that more than half the people in the survey did not accept plant-based diet because they did not want to try something they were not familiar with. The rejection of unfamiliar foods is called food neophobia (Pasqualone, 2022) which is also one of the main reasons for the unacceptance of plant-based meat as it prevents people from tasting new products. But compared to mycoprotein or cultured meat, it has an advantage in terms of familiarity and it has been on the market for decades now specifically in the category of plant-based protein source and certainly perceived to be healthier and more sustainable. For the age groups between 14 to 16 years old, social surroundings like school and home would play a key role in familiarizing oneself with plant-based diet and lead to a behavioral change. To improve perceived convenience and encourage meat avoidance, suggestions include providing knowledge on vegetarian meal preparation, offering a wider range of vegetarian options, information campaigns, and ready-made vegetarian meals. Injunctive norms, influenced by information campaigns, also play a role (Schenk et al., 2018). Szejda et al. (2020) suggests that highlighting plant-based as an easy replacement in one's traditional meat-based food would ease the process of acceptance of plant-based alternating without having to make a major change in their eating behavior.

3. Materials and methods

The method used here has multiple phases. In the first phase was a general questionnaire prepared on QualtricsXM® and sent to the participants, then an initial screening was done to divide then participants into three groups based on the selected questions, in phase three was the knowledge card and cooking class intervention followed by stage four of one-on-one semi-structured interviews and finally qualitative analysis involving coding and thematic analysis. A visual presentation of the same can be seen in Fig 3.



Fig 3: Schematic overview of research methodology

3.1 Phase 1 General questionnaire

Initially, a poster was made to approach participants between 15-24 (adolescents and young adults) circulated in WhatsApp and Facebook groups to approach participants from all over Netherlands. The posters were put around student buildings in Wageningen. Those who agreed to take part, who were within the age category and who lived in Netherlands were individually sent out the questionnaire as can be seen in Appendix 2. This questionnaire was prepared on QualtricsXM® and was sent to the participants via their email IDs and completed at their convenient locations. A pilot survey was done with 3 participants in the age group 19-25, both from Netherlands and other regions. These participants were not a part of the main study. Based on their reviews, a few changes were made to the main questionnaire. Out of the 30 people who agreed to take part, 24 filled in the questionnaire and only 16 fully completed the questionnaire and were a part of the study. All the questionnaire. Another criterion for the selection of the participants was their availability for the cooking class which was conducted in Wageningen. Only those who agreed to this were taken into the cooking class group and the others were taken for the rest of the study.

The questionnaire was structured in a way to understand the adolescent's knowledge of plant-based meat alternatives, familiarity with the subject, and their rating of cooking skill. This acted as a base to divide the participants into groups for knowledge and cooking class provision. The questionnaire was designed similar to a survey on consumption of meat alternatives and substitutes consumption conducted for Dutch consumers (Elzerman et al., 2021). The questions were divided into 5 parts. Part 1 had questions on socio-demographics and current dietary practices. Part 2 questions to check knowledge (question number 7 to 9) of PBMA (plant-based meat alternatives) were obtained from various sources and contained both multiple-choice and also on a 5-point Likert scale ranging from "totally disagree" to "totally agree" (Faber et al., 2020). The frequency of food consumption on both meat and plant-based meat alternatives were covered in part 3. Part 4 had questions on familiarity with the PBMA and willingness (questions 14 and 15) to try and replace meat with PBMA on a 5-point Likert scale ranging from "not at all willing" to "extremely willing". The final part 5 had questions on cooking skills (questions 21 and 22) where the participants rated

their own skills on a 5-point Likert scale ranging from "extremely bad" to "extremely good" for both meat and PBMA ingredients.

3.2 Phase 2: Group division for intervention

The answers from the questionnaire in phase 1 were exported to an excel sheet. To test the knowledge, familiarity and cooking, questions 8 - 9, questions 14-15 and questions 21-22 respectively were analyzed. Based on the mean score of the participants' responses, they were divided into three groups for further analysis (section: Results, Table 1). Questions 9_1 to 9_6 were reverse coded by subtracting their scores from 6, so that 1 becomes 5, 2 becomes 4, and so on as the questions were negative statements. The aim was to identify participants with low knowledge and low cooking skill to further provide intervention (knowledge card for low knowledge group and cooking class for high knowledge group) and analyze the effect on acceptance of PBMA. In order to clearly understand the effect of intervention, the groups were divided such that there is diversity. For instance, the group who got knowledge card would have participants with both high and low knowledge along with those who had high and low cooking skills. The group who would get cooking class would have participants with high and low cooking skills along with those who had high and low knowledge. The reason for such division is to know and understand if having low and/or high knowledge and low and/or high cooking skills would have any change or effect during intervention. Finally, the other participants who aren't in either of the groups were kept as control group who would not receive any intervention. This would help understand the difference between groups. The control group had participants with low and/or high knowledge and low and/or high cooking skills.

3.3 Phase 3: Intervention

As suggested by a study from Havermans et al. (2021b), children in middle adolescence (14-16 years old) can learn about plant-based foods through their school and home environments. It also suggests that mandatory training could lead to a shift towards plant-based diets along with nutrition education, which includes teaching how to prepare plant-based foods. Hence, to understand the change in perception, one group was given a knowledge card (Appendix 3). The information covered definition, benefits of PBMA like protein source, fiber source, lesser environmental impact, specific micronutrient source and points to be considered while consuming PBMA (George et al., 2022; Gardner et al., 2005 Voedingscentrum, n.d.; Mariotti & Gardner, 2019). The knowledge card was provided prior to the one-on-one interview and the participant was given time to read and understand. Approximately 5 minutes was taken by each one of them to read the entire card.

Another group received a cooking class. All the participants were called to a specific location on the same day but at two different time slots based on their availability. Once the participants entered, a brief introduction of the thesis was given. Before the class, participants filled out a form consenting to participation and food preferences and allergies were considered. In the cooking class, basic skills of washing, chopping, mixing and scaling of ingredients were taught step-by-step to make a raw plant-based taco (since no kitchen was available with a hot stove). The equipments and the ingredients needed were provided to the participants. The aim was to also include various plant-based sources like beans, vegetables, grain-based products (taco shells) and sauces and seasoning for flavors. The product's time, ease of cooking and taste were considered. The class took an hour by the end of which each adolescent in the group had made two tacos combining all the ingredients and following oral instructions. The pictures of the recipe ingredients and the participation in cooking class can be found in Appendix 4. The recipe for the tacos can be found in Appendix 5. The interviews were conducted after the cooking class. The group 3 did not get an intervention and was taken as control group.

3.4 Phase 4: Semi-structured interviews

Consenting participants participated in individual interviews, either in person or via Microsoft Teams. Interviews were audio recorded using the mobile app Voice Memos and semi-structured to provide an unobtrusive insight into participants' experiences while also allowing the researcher to keep the discussion on track (McIntosh and Morse, 2015). A pilot interview was conducted with 1 person (who did not take part in the main study) which took approx. 30-40 mins each but in the main interview there was no time limit. They were completed when all questions were asked. Interview lengths ranged from 20 to 45 minutes. An interview guide, as described in the Appendix, was administered to the participants, providing a more detailed understanding of the effect of knowledge and/or cooking skill. The interview guide's (Appendix 6) questions include the core question and many related questions to the central question, which are improved further through pilot testing. The main themes covered in the guide were definition of PBMA, general factors affecting consumption of PBMA, consumption frequency of meat and PBMA, knowledge questions (on protein, energy, micronutrients, fiber, micronutrients, treating non-communicable diseases, digestibility, environment friendliness), knowledge sources, willingness to try and replace PBMA, purchasing frequency, cooking skills (on beans and legumes, vegetables, mushrooms, nuts and seeds, tofu/tempeh and rice, pasta, and other cereals and grains), future prospects of intervention and effect of intervention on acceptance of PBMA. Magaldi and Berler (2020) argue that a semi-structured interview allows a researcher to delve deeply into a discovery.

3.5 Phase 5: Thematic analysis

The qualitative analysis tool Atlas.ti was used to code and analyze the data. Thematic analysis was used to investigate the effect of knowledge, familiarity and/or skills on acceptance of PBMA. Other barriers and facilitators for accepting PBMA were also analyzed (McInnes et al., 2023c). In the pilot analysis, multiple codes were developed by reading through the data which was confusing and resulted in too many codes which would then be difficult to analyze. Hence, the main knowledge questions were considered the main themes and codes were developed for each knowledge question. For example, the theme was to identify if the fiber knowledge affected the acceptance of PBMA for which the main code was 'Fiber knowledge' which was split into sub-codes as 'Fiber knowledge: low' and 'Fiber knowledge: high' and these were grouped into main codes as 'Positive influence of knowledge on acceptance of PBMA' respectively. Similarly, it was then done for cooking skills. For familiarity and other relevant factors which influenced acceptance which was out of the scope of theme, were categorized under knowledge and skill were given new codes and/or added under the already developed codes for knowledge and cooking skills.

Hence, in the final analysis, the main themes chosen were the questions asked under each specific topic of factors (knowledge, familiarity and cooking skill) influencing acceptance of PBMA. The transcripts were analyzed to identify knowledge-related themes based on responses to specific questions (8, 9, 11-18,30) from the interview guide. Additionally, participant responses throughout the interview were examined to determine if knowledge influenced their choice of PBMA. The same applied to cooking skills where the participants were asked questions (22, 24-29, 31) about cooking skills related to PBMA based on which the themes were built. For familiarity, the themes were based on responses where the participants described the effect of family or cultural background or other factors on their acceptance of PBMA. To interpret the effect of intervention (both knowledge card and cooking class) specifically, question 32 was analyzed. Additionally, the self- expressed responses to interventions were also coded and analyzed. Although the questions asked during the interview were modified according to participants' responses, all the questions in the guide were asked in the same order to keep the interview flow. A combination of deductive and

inductive analysis approach was chosen (Bingham, 2023). First the data was coded aligning the research questions. The deductive codes were developed based on the key aspects of the research question. This was mainly done for knowledge-based themes and cooking skill-based themes. To answer the question of familiarity and other related factors effecting the acceptance of PBMA, inductive analysis was done where the data was read through, and codes were identified and themes were built as they emerged (Miles et al.,2020). The key themes developed can be seen in Table 8.

4 and 5. Results

4.1 Participant characteristics

The answers from the questionnaire in phase 1 were exported to an excel sheet. To test the knowledge, familiarity and cooking, questions 8 - 9, questions 14-15 and questions 21-22 respectively were analyzed. Based on the mean score of the participants' responses, they were divided into three groups for further analysis (Table 1). Anyone below the mean score in each category were considered to have low knowledge and familiarity (mean = 3,5) and low cooking skill and familiarity (mean = 3,4).

The groups were divided such that there would be diversity in terms of knowledge, familiarity and cooking skills. In one group, G1 were participants with low and high cooking skills and with low and high knowledge who would get a cooking class while in G2 were the participants with low and high knowledge along with those who had low cooking skill who would get a knowledge card. G3 was the control group meaning they did not receive any intervention.

The 16 participants belonged to the age group 15-21 years old. The participant's description can be seen in Table 1.

P. No	Age	Gender	Nationality	Knowledge	Cooking skill and familiarity	Willingness to try and replace meat with PBMA	Interventio n group
P17	19	F	Indonesian	3,6	3,3	3,3	
P21	19	М	Indian	3,1	4,4	2,8	
P11	19	F	Dutch	3,1	3,2	2,9	G1 (cooking
P5	18	F	Norwegian/ Brazilian	3,5	2,8	3	class)
P4	21	М	Dutch	4,1	4,3	4,2	
P20	20	М	Dutch	3,4	3,8	2	
P12	20	F	Dutch	2,6	3,0	1	G2
P10	19	F	Indian	3,1	4,5	3,8	(knowledge
P14	15	F	Dutch	2,8	3,0	1,4	card)
P8	19	F	Dutch	4,0	3,2	4,3	
P7	19	F	Dutch	3,9	2,3	4,3	G3 (Control
P2	17	F	Belgian	3,6	3,3	3,8	group)

Table 1: Participant description: social demographics, average scores of questions answered and division of groups for intervention.

P15	20	М	Dutch	3,7	2,3	3,6
P22	19	М	Indian	3,6	4,2	2,9
P16	18	F	Indonesian	3,9	5,0	4,3
P23	21	М	Cambodian	3,3	2,0	2,8

4.2 Participant's definition of plant-based meat alternatives

During the questionnaire and interview it was made clear to the participants that the study was about their perception of natural and traditionally processed plant-based meat alternatives and not the analogues. After which the participants were shown images of alternatives (Appendix 1) out of which all of them choose a few natural ones like the nuts, legumes, vegetables, mushrooms, beans etc. and when asked also mentioned they considered processed products like vegan burger, fake meat etc. also to be plant-based alternatives. Only P15 considered all the mentioned items in the list to be plant-based meat alternatives. The rest though choose only a few alternatives to be suitable meat replacers. The most common definitions analyzed in this category are mentioned in Table 2 where beans and legumes were often chosen as PBMA while almost an equal number also defined them as analogues or processed foods. Vegetables, mushrooms, nuts were among the other natural alternatives chosen by the participants. The traditionally processed tofu and tempeh were also considered to be PBMA by a relatively large no.of adolescents. Along with this, participants when asked about their definition of a 'good plant-based meat alternative' mentioned they considered items rich in protein, iron, vitamin B12, good taste, texture and smell like that of meat to be good alternatives to replace meat. The key themes in adolescents' perception of a good plant-based meat alternative can be seen in Table 3. The major factors for acceptance or non-acceptance will be explained further. Initially the participants described the PBMA as both natural and processed but through the interviews it was interpreted by the participants as natural and traditionally processed and not processed.

Key definitions of plant-based meat alternatives	No. Of participants
Beans and legumes	14
Vegetables and mushrooms	13
Nuts and seeds	11
Tofu and tempeh	11
Jackfruit, algae,seitan	10
Oat flakes	3
Pasta and rice	1
Other : processed/analogs	13
 Vegan chicken burger/patties/soy products 	7
- Fake meat	2
- Analogs (with similar structure of meat)	4

Table 2. Farticipants demittion of plant-based meat alternative	Table 2: Partici	ipants' definition	of plant-based	meat alternative
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High protein	4
Sensory factors (good taste/smell/texture)	5
Vitamin B12	2
Iron and other micronutrients	4
Environment and animal friendly	1

Table 3: participants' perception of a good plant-based meat alternative

5. Factors influencing acceptance of plant-based meat alternatives

The main themes for knowledge were chosen based on the interview questions and hence are discussed in details below. The key themes discussed can be seen in Table 8. All the knowledge questions were taken as main themes as they all had an influence on acceptance of PBMA.

5.1. Influence of knowledge

5.1.1 Health and nutritional aspects

5.1.1.1 Digestibility

Acceptance

Participants (n=11) found PBMA easier to digest based on subjective experiences, suggesting a potential link between knowledge of PBMA and perceived digestibility where the knowledge is based on one's personal experience. "I went to an all-you-can-eat and well, you have to eat all of the meat.... And then the day tomorrow I would always have a bad stomach.... So it is from my personal experience I can say plantbased meat alternatives are easier to digest." (19 female, Indonesian) and P10 also shared the same view. Understanding the nutritional composition of vegetables and oat flakes, particularly their high fiber and water content, influenced participants' perception of them as easy-to-digest options. "you have a lot of bacteria in our guts who are able to process these vegetables....eating vegetables has a lot of positive effects on your gut." (20 male, Dutch). Knowledge of proper preparation techniques, such as soaking beans and legumes to reduce anti-nutritional factors, impacted participants' perception of their digestibility compared to meat. "The beans if you soak them before because that reduces the anti-nutrient that reduces the absorb ability of certain nutrients. So soaking them overnight is good for digestibility." and "tempeh is fermented so I think it's like the probiotics which is good for digestibility" (18 female, Norwegian/Brazilian). Participants associated the fermentation process in tempeh with improved digestibility, indicating a connection between knowledge of food processing methods and perceived digestibility. Knowledge of the physiological effects of PBMA, such as their impact on energy levels compared to meat, influenced participants' preference for PBMA "When I always eat meat, I feel sleepy.....it's not easy to digest. So I think that's why your body's working inside a lot." (19 female, Dutch). High knowledge and personal experiences with PBMA facilitated participants' adaptation to and incorporation of these alternatives into their diets, replacing traditional meat consumption.

Non- acceptance

Although a few participants (n=5) still questioned or argued about digestibility saying that the vegetarians had a tough time digesting other foods as the gut got accustomed to certain diets. Flatulence was also one of the reasons for the non-acceptance of chickpeas, beans and legumes.

5.1.1.2 Energy source

Acceptance

A lot of participants thought cereals and grain products like rice, tortillas, bread, noodles and pasta which are rich in carbohydrates to be energy dense (n=7) while the others thought vegetables and fruits were a reliable source of energy (n=6). "*if you have some oatmeal or if you have some pasta, like spaghetti or any kind of pasta, Um. Yeah, that's what I would say. It gives you enough energy for a longer period of time.*", (17 female, Belgian). Legumes, beans and oats were also chosen by 3 participants when asked about the energy source. Apart from that they also mentioned that it had been a part of their staple diet, which was also their reason for choosing the above items as a good energy source. Only 2 participants considered nuts to give a lot of energy throughout the day. Two of the participants chose to have only PBMA as they were vegetarians and believed that they get sufficient energy. "Whole plant based. Foods. Yeah. They give me a lot of energy because. Like they keep me full. Like I have very consistent amounts of energy throughout the day.", (18 female, Norwegian/Brazilian).

Non-acceptance

Three of the participants strongly believed that meat provided them with more energy and kept them energized throughout the day due to their personal experience or from the knowledge they received. "And of course, if you eat things like meat, you will get way more energy...I think if you, for example, eat one gram of meat and one gram of vegetables, you'll be able to take more energy from the meat than from the vegetables, I think" (20 male, Dutch). Three other participants either lacked knowledge or paid no attention to what they were eating as a source of energy. Two of them mentioned they choose a balance of meat and vegetables as a source of energy. "Rice and some vegetables. Yeah. It will be enough for me and meat on some days. A good balance of these two.", (19 female, Indonesian).

5.1.1.3 Fiber content

Acceptance

Almost every participant (n=15) mentioned vegetables, greens and oat flakes as the major sources of fiber. *"Everything from vegetables and fruits. It's mostly for your soul or your, uh, digestion and it's good to have it in your diet. Uh, yeah. Also, to prevent diarrhea "(21 male, Dutch).* Apart from this, legumes, nuts and cereals were also considered to have fiber. The choices were made due to personal experience and knowledge from parents. *"Oh, I think it's from personal experience. I got constipated for a whole month. I eat meat every day. When I went back home. My mother told me to eat lots of vegetables and then I finally got a good digestive system...I need the fiber from the vegetable" (19 female, Indonesian). "I think nuts and beans because my mom always said it helps you if you're constipated. Yeah, I heard fruits have a lot of fiber. I think oats too have a lot of fiber." (19 female, Dutch). Only one adolescent mentioned mushroom as a fiber source. The influence of school and online sources also played a role in acceptance of PBMA as a reliable source of fiber among a few participants. <i>"I use a lot of vegetables and also bread. I'm studying food technology, so I know quite a lot about the composition of food, so. I know there's a lot of fiber in those foods. And also, my parents have told me and people just around me, I haven't really read literature about it" (19 female, Dutch).*

Non-acceptance

Since some participants were not aware of the fiber source, their fiber intake was met through medications although they ate vegetables. Only two participants were completely unaware of the fiber sources while

one of them mentioned *"some greens"* but was not entirely sure which showed lack of knowledge of the fiber source and hence non-acceptance of PBMA.

5.1.1.4 Vitamins and minerals, Iron and Vitamin B1 in nuts and Vitamin B12 content Acceptance

A few (n=3) of the participants were convinced that nuts had vitamin B12 and vegetarians for a long time had survived on plant-based sources which also proved that there are enough micronutrients in PBMA but not specifically from nuts. "If you remove meat from your diet and if you also add nuts to your diet, then you probably will have the vitamin requirement fulfilled." (19 male, Indian: P22). The influence of knowledge source can also be seen in acceptance of nuts as a thorough source of micronutrients to replace PBMA ."Yeah. I think I've read something about it, um, a few years ago, cause I was helping with, um, someone.... they were having, dehydrated, cashew nuts. So. Yeah, I heard it a bit about it, and heard it was quite helpful" (21 male, Cambodian). Apart from nuts, other PBMA have also been accepted as reliable sources of vitamins and minerals and have been used to replace meat in diets. PBMA as source of vitamin B12 and not only meat was also discussed by a no.of adolescents (n=7). "When it comes to tofu, I have read something once that it contains a lot of vitamins and minerals" (20 female, Dutch). "mushrooms do contain it as well. (vitamin)" (21 male, Dutch). "I think they (vegetables) contain a lot of vitamins and minerals and then I think they're the staple food. They also go well with chicken." (19 female, Indian).

Non-acceptance

Nuts and seeds were not often used as a meal but as a snack hence most people did not consider them to be a replacement for meat although a few (n=5) thought nuts had a sufficient amount of iron and vitamin B1 but not to replace meat. "Yes, I do think they have a small amount of it, but I don't think it's enough because meat is very big and almonds are tiny. I eat nuts but I don't think they are replaceable by meat." (19 female, Dutch). "Well, it has the vitamins and the content, but I don't think so because also in my consumption, I only make it as a salad, as a side dish, or I snack on it. So it's not really like a replacement per se." (19 female, Indonesian). In spite of consuming nuts and adapting to a plant-based diet, a few (n=) adolescents did not think PBMA offered sufficient vitamins and minerals, but they did believe that nuts had a good nutritional value overall and were encouraged to consume."...I do eat a lot of nuts because they're a bit more expensive, but I just really like them and they offer good nutritional score." (21 male, Dutch). "Well, you would have to eat quite regularly and quite a bit to get that iron. It depends on the type of nut. I think the flax seed, if you grind it you get a lot of omega threes. So that's Important but apart from that I am not sure if nuts have a sufficient amount of iron and Vitamin B1" (18 female, Norwegian/Brazilian). One of the other major reasons mentioned by one of the participants was the knowledge received on the internet which acted as a barrier in the acceptance of nuts as a PBMA. "Because I don't know where I saw it, but it was like on a TV program about meat alternatives that it was very difficult to be, to have enough protein and to have like, those vitamins in meats. So, I think maybe if they combine nuts and seeds with other products, it could be a meat alternative and not only nuts and seeds" (19 female, Dutch).

When it came to sources of vitamin B12 a relatively large no.of adolescents truly had little or no knowledge at all (n= 7). They either received false information or little information from school, the internet, workplace or from family and other external sources. "vitamin B12....I know that they are also present in plant-based meat alternatives, but you have to consume a lot of amount of these alternatives to get vitamin B12 and a lot of iron.....I do a part-time job at a pharmacy while I study and I get to talk to GPs (general practitioners) and pharmacists a lot...and they told if someone doesn't eat a lot of meat, they need to take vitamin B12

supplements." (19 female, Dutch). Some took pills or supplements (n=2), while a few thought it was either only from animal source (n= 3) or not sufficiently available from PBMA or they were aware of sources but not very sure of the knowledge they had as can be seen from responses. "Mostly from meat, from animal products. Uh, but also for instance, from mushrooms" (21 male, Dutch). "I only know about Vitamin B12 which is from the nutritional yeast as a natural source I believe." (19 female, Norwegian/Brazilian).

5.1.1.5 Non-communicable diseases: high cholesterol and insulin levels Acceptance

Vegetables were considered to be the most suitable PBMA by participants (n=9) to consume for those with high cholesterol and insulin levels. "I think it's (vegetables) very good for the blood vessels, makes it wider, you know, it will prevent, the oils and fats from getting stuck. I barely hear bad things about vegetables so I think it is always safer to eat it. So I think it's very good for the body, doesn't have bad things, you know." (20 female, Dutch). "Lot of vegetables and I think they should skip all the junk that they eat. And then eat a lot of tofu and mushrooms which have a lot of protein in them. So they can replace it. meat with that and then they can cut down the Whole wheat which is also not good." (19 female, Indian). The other alternatives mentioned by adolescents (n=6) were oats, pulses and legumes and a very few mentioned nuts and mushrooms along with mentions on low salt and sugar content. "Oats, because I once researched about the benefits, and it says that it can cure like it can decrease cholesterol levels" (19 female, Indonesian). "Nuts and vegetables also give us the best option. I think tofu, mushrooms and oats are also good, but I don't know for sure. I just think they should eat something natural and avoid processed foods." (19 female, Dutch). Three of them suggested that meat be avoided or reduced in such conditions based on the knowledge either from courses or from people around. "I think they should be eating a lot of pulses, vegetables and avoid meat." (19 male, Indian). One participant with extremely high knowledge mentioned that she shifted to veganism because PBMA have either extremely low cholesterol or no cholesterol at all. Added knowledge on diabetes from documentaries also lead them to believe that saturated fats are also a cause for insulin levels.

Non acceptance

Some of them (n=4) gave a more general explanation like avoiding processed and fried foods, cutting down on sugar and replacing it with something healthy like a candy with an almond which portrayed good knowledge but not specific to PBMA. A contrasting opinion was also about nuts which were considered harmful for people with cholesterol due to its high oil content. "I wouldn't really recommend the nuts and seeds because it's also like high in fat. It's good fat, but it's fat. Yeah, I think I would stick with the vegetables" (19 female, Dutch). "I wouldn't think they all nuts and seeds would be good for them. Because different nuts and seeds have different levels of oil." (19 male, Indian). One adolescent although had good knowledge about PBMA, was still not assured that they could cure non-communicable diseases. "I don't think it's really that you can solve it with nutrition alone. Because you can eat low cholesterol foods and that's probably because cholesterol is only in meat products or animal products so. Sure. Replace the completely and you do get less cholesterol in your blood I guess. Uh, but it's yeah, I don't think it will have like immediate effects if you just eat less meat." (21 male, Dutch).

5.1.1.6 Protein content

Acceptance

Most participants (n= 7) preferred a balance between PBMA and meat for protein source or used PBMA sometimes along with meat and dairy sources "most of the time I get my protein from meat, but if I do not

eat meat, then I get it from beans and the most important one I use is tofu." (19 female, Dutch), while a good no.of participants also got their protein entirely from plant-based sources (n=5). Among the PBMA, adolescents mostly choose tofu/tempeh, beans and legumes, nuts, vegetables and oats as a good protein source. "This is the main one tofu because of the high protein and because it's just easier for digestion.... So, I eat oat bran because it's higher in protein than the actual flakes." (18 female, Norwegian/Brazilian). "Oh, tofu definitely has all of the amino acids. Beans, I think if you combine different kinds of beans and vegetables, I think you can use them to replace meat." (20 male, Dutch). "Beans and legumes because they contain a lot of protein and are a great replacement." (19 female, Dutch). "I would include a lot of beans, lentils, chickpeas, and also a lot of nuts...beans and legumes because they contain a lot of protein and are a great replacement." (19 female, Dutch). "You can go nuts or just like an alternative. So, like tofu seitan. Um, and I think if you just eat enough, then it's okay." (17 female, Belgian). Although the participant consumed PBMA, he expressed his concern on the quantity of PBMA to be consumed to get the equivalence of protein as in meat. "Um, vegetables, you have to consume quite a lot to get enough. For instance, beans and legumes are a bit denser, and also nuts are quite dense because they don't have much water in them. Mhm. But for other sources, you have to push in quite a lot to get the same amount as meat. Mhm. Um. So yeah, quantity-wise, I think for most vegetables you have to consume two or three times as much as meat to get the same amount of protein." (21 male, Dutch).

Non-acceptance

One of the participants, although she consumed only PBMA found it difficult to get all the protein from natural sources due to personal health goals or liked meat too much. "I don't think this the vegetables contains a lot of protein." (18 female, Indonesian). "Like the taste of poultry and I think it has a much higher protein content per 100 grams or what are the basis compared to plant based alternatives. At least that's what I believe. I don't know the exact metrics of it." (19 male, Indian). "it's kind of difficult to be on a plant-based diet because most of the natural protein sources, so not fermented, such as tempeh are very high in carbohydrates as well.... If you buy uncooked beans, the dry ones for every 100 grams are like 300 calories and 20 grams of protein. And, uh, depending on the beans, it has either 30 or 50 grams of carbohydrates...So, you end up with, like, a big percentage of the calories that you get or carbohydrates, and then only a little bit is the protein.... going to the gym and if you want to like, okay, I will do cuts, you know. Lower the calorie intake, but you still need the protein because if not, your muscle disappears. Then it's hard with the plant based" (18 female, Norwegian/Brazilian). She also didn't believe seitan to be a suitable alternative due to incomplete amino acid profile and its allergic effect on people with gluten intolerance. A few participants (n=2) did not have a lot of knowledge about PBMA and just picked anything with 'high protein' on the product or just any food source. "By eating meat at dinner and I always have Quark for breakfast and with lunch, like eggs or some meat, cottage cheese, anything like that." (20 male, Dutch). While for the other adolescents (n=3), meat was an important source of protein. "Of course, meat would be the most important one, also eggs. So honestly, I don't really keep track of what the contents are of what I eat, but mostly on the variety of what I eat." (20 male, Dutch). The same participants also didn't prefer vegetables, nuts or grains as protein alternatives which showed low knowledge about protein sources and affected their acceptance of PBMA. "Nuts still contain protein, but you don't want to eat large enough amounts of nuts for sufficient protein because they're also really fatty. So that's why I won't consider them a meat alternative. With grains, I don't see them as alternative because I don't think any of them have a complete amino acid profile." (20 male, Dutch: P20)

5.1.2 Animal welfare

Acceptance

Very few adolescents (n=3) chose to eat PBMA due to their values regarding animal welfare. This was due to the background they grew up in "I think it's really nice because. We used to breed like rabbits or chickens. It was younger. And then when you have like taking care of the animal yourself and then you eat it it feels kinda bad" (17 female, Belgian), while for others it was the information they received on the internet and the sufferings of the animals that made them accept PBMA over meat. "But I still thought that I would continue with eggs and milk. But then I did some more research. And I was living in Brazil, so. And the dairy farms there, don't treat the cows very well. The hens that are egg-laying are also packed into small cages." (18 female, Norwegian/Brazilian).

5.1.3 Environment friendliness

Acceptance

Most participants (n=6) had a positive opinion on the environmentally friendliness of PBMA. Some said it was greener for the environment because it is grown on the ground. A few of them who were highly aware and knowledgeable mentioned that PBMA have a lower carbon footprint, produce lesser methane while others generally thought it was good for the environment but not very sure of the reasoning. A few adolescents explained how family, college and sources on the internet played a huge role. "I think they are (environment friendly). They have a lower carbon footprint, and it is way better for the environment and ourselves." (19 female, Dutch). "I think it's better if I avoid eating some steak. It would take a lot more water to produce it than if I were to go for alternatives. So I think that's something. As a human you can already do your part in the entirety of global warming to reduce your ecological footprint. This, of course, has to go with other things as well, but I think is a good start to stop eating meat or at least less meats, because it will already do a lot if just like one day a week if we eat alternatives... my mom like sending me articles about it and. Yeah, just doing your own research on it. There is a lot of scientific proof about it, so it also helps... or get to know about it when you start caring about it. And which is really easier in Wageningen because everyone shares that opinion and we're kind of in a bubble" (17 female, Belgian).

Non-acceptance

A few participants offered their opinion on the negative impact of foods like avocados and water used for bread processing on the environment. The effects of agricultural practices and certain fertilizers used in growing plants were also talked about by the adolescents but had no negative impact on their plant-based meat alternatives consumption. "So okay you're eating plant-based which is mainstream. They say it's good for sustainability but you're eating lots of avocados from Brazil. And you're eating the bananas from Spain and tomatoes from Italy. And you buy potato chips that have been highly processed because instead of buying the potatoes from the organic farm like in the Netherlands, you can buy potatoes from your neighbor." (18 female, Norwegian/Brazilian). "I think it's better. But, I mean, uh, to produce, um. Like bread and stuff. I mean, I've heard that that's caused a lot of water and like, uh, it's not good for the environment to produce. So I'm just like. But these are these ingredients, and they're just harvested from just like. Would that be environmentally friendly? I do think so. But they use machines to harvest vegetables it's also good for the environment." (19 female, Dutch). Two of the participants had no knowledge, but that didn't influence the acceptance of PBMA.

5.1.4 Influence of knowledge card

Positive effect

The provision of knowledge card positively influenced the acceptance of PBMA on three out of five people who received it (participants in knowledge card intervention can be found in Table 1). These participants were in a diverse group of those with low knowledge and high knowledge. The positive effect of knowledge card intervention was seen in those who had low knowledge (P10) and/or low cooking skills (P12, P14). The effects were self-expressed during the interview and when asked specifically about the effect of knowledge card. The difference was also observed in comparison to their responses in 'general questionnaire' (Phase 1) and during the interview as can be seen in Table 4. It is still unclear with other questions if the card had a positive influence or a negative influence as there were no mentions of the interventions and not much of a change in knowledge during the interviews which could be that either the card was not effective or not convincing enough which is discussed further.

The facts mentioned in the card mainly helped the adolescents with good knowledge and nudged them towards discussing acceptance with family and friends. The information was also reachable to different age groups and helped them perceive PBMA better as can be seen from the responses of participant P14 and P10. With one of the participants P12, the card confirmed with the information they were aware of and enhanced in a few areas who mentioned in by themselves during the interview and was also analyzed from their earlier answer from Phase 1. Participant P10 was also convinced of the benefits of PBMA mentioned in the knowledge card and considered replacing meat with PBMA as can be seen in Table 4.

P.No	Knowledge: Self- expressed /Questionnaire analyzed/ both	Question analyzed from 'General questionnaire'	Participant's answer in the 'General questionnaire'	Interview question analyzed	Participant's answer in interview (post- intervention)
P12	Both	"Consumption of legumes and other plant- based foods are used to treat non- communicable diseases like blood cholesterol and insulin levels" [strongly disagree (1) to strongly agree (5)]	Disagree (4) with the statement	What kind of food do you think people with non- communicable diseases like blood cholesterol and insulin levels should consume? why/why not?	"Plant-based alternatives also help reduce cholesterol as mentioned in the knowledge card and I also am aware of it because when I look at my genetics, I know a lot of people, you know, they struggle with cholesterol. So that's one of the reasons why I think I have to eat it more'"

P14	Interview question	_	-	How did you feel about the knowledge card? Do you think the knowledge card helped you in any way to change your perspective towards	"I didn't know they were that high in fiber, and umm, like did they also cure diseases like high cholesterol or diabetes"
P10	Interview question	-	-	PBMA? How did you feel about the knowledge card? Do you think the knowledge card helped you in any way to change your perspective towards PBMA?	"I didn't know that plant- based meat alternatives are low in fat. I did not know about vitamin B12 content as well I feel I am more convinced to eat plant-based meat alternatives in place of meat in my meal as I now know the nutritional values, and their benefits."

No effect

Since the group was diverse, it also had people with high knowledge on PBMA who still found a few facts to be interesting although it did not make much of a difference in their acceptance. "I knew most of it, but except for the 4 to 5 item in which vitamins are in which food like nuts and seeds, there's a limited amount as well like vitamin B12 which is also available in plant-based food but not also not all of them have it. That was most new information for me." (19 female, Dutch: P8). For one of the participants, though they had low knowledge, the card did not affect their acceptance of PBMA as the information mostly." (20 male, Dutch).

 Table 5: Overview of knowledge themes

Торіс	Knowledge	
Digestibility knowledge	High (n=11), Low (n=5)	
Energy content knowledge	High (n=13), Low (n=3)	
Fiber content knowledge	High (n=14), Low (n=2)	

Non-communicable diseases: high cholesterol and insulin levels knowledge	High (n=15), Low (n=1)
Protein content knowledge	High (n=11), Low (n=5)
Iron and Vitamin B1 in nuts and Vitamin B12 content knowledge	High (n=10), Low (n=6)
Environment friendliness knowledge	High (n= 8), Low (n= 8)
Animal welfare knowledge	High (n=3), Low (n=13)

5.2 Influence of familiarity

5.2.1 High familiarity

Acceptance

A reasonably higher (n=9) no.of participants chose to eat PBMA due to high familiarity. Some were comfortable choosing tofu as they had heard a lot about it, "*Tofu, I think because I've tried many vegan and vegetarian dishes with it. And I think vegetables, mushrooms, beans, nuts, and jackfruit too*" (19 female, Dutch) whilst others preferred beans and legumes either due to familiar taste or cooking convenience. "*I do know how beans and legumes taste. You, you can use them in a lot of different ways.*" (20 male, Dutch). "*Since, I already know how beans and legumes work. So that would be more of a comfortable choice.*" (19 female, Dutch: P7). "*Red beans and chickpeas I choose them mainly because of the familiarity.... I regularly consume chickpeas and red beans and yeah, I try to eat tofu sometimes. Okay. So yeah, but regularly I think I eat chickpeas and beans. They are a staple part of my diet. "(19 male, Indian). Seitan especially was only known to Europeans (n=5) but was accepted as an alternative only by two adolescents.*

Non-acceptance

Adolescents were least familiar with seitan and jackfruit. Most people never heard about it at all, or they did not consider them PBMA. "*I have never eaten jackfruit or seitan and I do not know much about algae.*" (19 female, Indonesian). "*I don't know about seitan, but I do not think it is a plant-based meat alternative.*" (19 female, Dutch).

5.2.2 Family, friends, culture and external factors Acceptance

The influence of family, culture, location, workplace among other factors played a role in terms of familiarity with PBMA and hence its acceptance (n=5). Two of the adolescents preferred tempeh as an alternative to meat as it is a staple food in their home country. "*Tempeh because in my country we eat a lot of them*", (18 female, Indonesian) "*You know, back at home, I really like this one (tempeh)*. So they fry it in different ways in my home country. I would eat it every day with only rice for breakfast, lunch and dinner because it tastes so good. But it's fried." (19 female, Indonesian). "I mean, friends and family could convince me to also try it. I mean, when I go to someone's home, I will just respect her preference, and then I will just eat it... I do eat more vegetarian than were when I live with my parents, you know, after because it's a different culture in Wageningen" (19 female, Dutch: P11). "I would say Seitan. But I don't know why. But we always used to eat. And when we were children, we just used them as meat replacer." (19 female, Dutch: P8). "If my parents make me, then I will definitely eat it "(19 male, Dutch)

Non-acceptance

In a few instances, influence from family, friends and cultural background had a negative influence on familiarity with PBMA. "Pakistanis really like meat. It's so it's I think if I would be I will become vegan or vegetarian and my parents would be like, why are you doing this?" (19 female, Dutch). "I'll just eat what you're cooking because if you're asking for a vegetarian option then it becomes annoying, because everyone they don't always understand and it's just not always possible. So then I think I would like eat maybe like three or four times a week meat" (17 female, Belgian). Certain eating habits since childhood also played a role in meat likeliness and less adaption of PBMA "I think since I was a kid, I always I only eat meat, but I also eat vegetables for like very minimum to the point that, like, you don't really count it." (21 male, Cambodian). "I think it's just because when I make a meal. I'm thinking as a typical Dutch, you know, meat, vegetables and potato. And it's kind of harder to incorporate plant-based alternatives into that structure, I think." (20 male, Dutch: P20).

5.2.3 Sensory factors

Acceptance

One of the major factors for acceptance of PBMA was familiar taste and texture. Three participants specifically gave mushroom as a suitable alternative due to its characteristic texture which mimics meat or is similar to meat, "I would say mushrooms as well. Yeah. I don't really like to eat them but. They're great. Especially because they have a similar structure to meat." (19 female, Dutch), "mushroom will help with the texture like that of meat. So it should have good texture, filling, and bit of taste also." (19 female, Indonesian), "I think it's about texture again. Taste. I'm not sure how much they can emulate the taste of meat in the meal, but texture wise, there are different types of mushrooms that can emulate the texture of chicken or something like that. Or even Tofu and Tempeh have similar characteristics. I've never had jackfruit as a meat alternative, but I know of it having a similar texture." (19 male, Indian: P22). While for three others it was the taste good cause then when it's in like the sauce and everything, it has less the alternative tastes. So you really have to put it in place of your meat" (17 female, Belgian).

Non-acceptance

A total of 12 participants mentioned sensory factors as the reasons for non-acceptance of PBMA. A few spoke about smell "I'm very sensitive to smell. So it's probably the smell. Cause like, I know mushrooms and they have like a certain smell. And sometimes if I consume too much of it, it makes me a bit dizzy." (18 female, Indonesian). While a few mentioned taste, "I am willing to try this except oat flakes because it cannot give meat taste." (19 female, Indonesian). Some did not like the texture of seitan, mushroom, tofu, algae and jackfruit too. "It's just the taste and the structure. I don't like (mushroom and algae)." (20 male, Dutch: P15). Three out of five participants who were familiar with seitan did not choose to eat it because of the visual appearance and allergen properties.

5.3 Influence of cooking skill

5.3.1 General cooking skills and convenience of plant-based meat alternatives

During interviews, most adolescents discussed the ease of cooking with PBMA compared to meat and found it safer. They also found it convenient in terms of efforts to make the dish tastier. "I think they are easier to cook with. There are less things that could go wrong, like raw meats or anything like that could have

serious effects on human health. And I think with vegetables and other substitutes, it's less of a problem. If you mess up or anything like that. So yeah, I think it's easier... just buy and mix everything and it tastes nice, but for meat, I need specific sauces." (18 female, Indonesian: P16). "I think it's easier to eat to make plant-based meat alternatives basically because you know when you're making, for example meat or something like that. It takes a lot of time and if it goes wrong, you can get salmonella." You can get sick when. I mean, when it comes to natural plant-based foods, even if it's a little bit raw, it's usually fine." (20 female, Dutch). Two of them do not cook with meat at all to compare but they found it easier to make multiple variations with the PBMA and found it very convenient to do so.

Some participants found it easier to cook with selective alternatives but found it harder to cook with others. P16 who found vegetables convenient to cook but when it came to legumes, was unsure. "No, Because I don't really know what to do with them. So, all I know is that I can make sweet desserts from them, but not like if I would ever put them in my meal. I feel like the texture is really weird. Yeah. Uh, yeah. Don't really eat them, though." (18 female, Indonesian). Another participant P17 also had a similar opinion who was also from Indonesia which could be due to more familiarity with certain ingredients that others. The other major reasons for not cooking with PBMA were lack of skills and recipes. "Honestly, I don't cook, my mother cooks. So everything she throws at me I'll eat, but what I tried is I don't know if it's plant based. If this is the same but soya" (20 male, Dutch). "There are so many dishes that I can prepare easily with poultry and I prefer them but when it comes to plant based alternatives, I don't have enough knowledge on how to prepare them." (19 male, Indian).

5.3.1.1 Cooking skills with beans and legumes Acceptance

A little more than half the participants (n=9) were quite comfortable cooking with beans and legumes as they had been cooking with it for a long time or know recipes. "Yeah, I'm always comfortable. I have been cooking with them for a really long time now." (19 female, Dutch). "I remember the last time I cooked Paella with the beans. And it was very easy." (19 female, Dutch). "I have used canned beans. I mix it with spices and make a wrap or a taco or a burrito bowl." (19 female, Indian). One of the adolescents had never cooked with meat but found it convenient to prepare meals with beans and legumes. "Well I've never cooked with meat so I don't know how to compare. I have always cooked with the beans. But I think it is easier." (18 female, Norwegian/Brazilian). For some (n=3) although it was not entirely easy to use legumes or beans (due to the extra step of soaking them), still chose to do so and willing to accept. "I'm confident with it. It's like with some things it's just more complicated than other things, but it's a practise. Yeah, that's just learning how to cook. Yeah, but it's easier, I think. Yeah" (17 female, Belgian). "I'm quite comfortable. And, um. Yeah, it does help if they're already prepared a little bit because for white beans, there could be hazardous if they're, uh, if you don't prepare them well. But I think I'm quite comfortable with it" (21 male, Dutch).

Non-acceptance

Seven participants had never cooked with beans and legumes due to lack of knowledge of recipes and/or low cooking skills. "*I don't think I've cooked them before*." (21 male, Cambodian). "*Oh yeah. I haven't really found like, a good recipe for it. Um, I don't really cook it because. Yeah, the salad. You just put those in. So I'm confused on how to cook them*" (19 female, Indonesian).

5.3.1.2 Cooking with rice/pasts, cereals and grains Acceptance

A relatively large no.of adolescents (n=12) found it easier to cook with rice and pasta irrespective of the cultural background. The reasons being the reduced cooking time and versatility of the dishes or that it had been a staple part of their diets. "...Rice. because I always need to have it in my meal." (18 female, Indonesian). "Yeah, with pasta, you know, with pasta, you could mix a lot of things. So definitely when I cook pasta sometimes, I always put vegetables and spinach." (20 female, Dutch). "think I'm pretty good. Okay. Yeah, I can cook almost all my basic Indian dishes quite well." (19 male, Indian). "Um, it's quite easy. I don't think you can mess much up with pasta or rice, so that's good" (19 female, Dutch). Participants who had a low cooking skill and were not comfortable cooking with other alternatives were still comfortable cooking with rice and pasta. "I think I'm okay with it because I use a rice cooker. Nothing can go wrong with a rice cooker. I am also okay with pasta." (21 male, Cambodian). Friends and place have had an influence on learning cooking skills related to PBMA for some people (n=2)."I think I can cook with it. Yeah, yeah. Most of it… A friend of mine was from Singapore that learn how to make rice properly. But that was really the last two years before that. " (21 male, Dutch). "I've been eating pasta and rice since I came here, so I am Very comfortable." (19 female, Indonesian).

Non-acceptance

A very few participants (n= 2) did not cook with rice/pasta at all or very less, which was not enough for them to consider it a replacement for meat. Two of the participants did not cook at all. "Honestly, I don't cook, my mother cooks. So everything she throws at me I'll eat, but what I tried is I don't know if it's plant based." (20 male, Dutch).

5.3.1.3 Cooking with tofu/tempeh

Acceptance

Tofu especially was preferred among the traditionally processed PBMA by a few adolescents as it was easy to cook with and knew a lot of recipes (n=5). "My favorite thing is tofu so I am very comfortable cooking with it" (18 female, Indonesian). "I see them(tofu and tempeh) almost as equals, it's almost the same and then I usually just take the tofu. Um, so yeah...Yeah, I'm familiar with both, but I usually just take the tofu and not tempeh." (21 male, Dutch). Participants were also willing to learn more recipes as they liked tofu. "I usually when I make tofu I just put it in soya sauce and then cook it on the pan. But I'd sure like lots of other ways that I see, but I just haven't tried yet. to prepare it." (17 female, Belgian).

Non-acceptance

Three adolescents found it extremely inconvenient to cook with tofu either because they had never cooked with it at all, or they lacked skills. "tofu is quite a new, uh.... So I need to search for recipes before I can use it. So that makes it more difficult. And I think also we need to add a lot of spices and stuff yourself, whereas the other products already have a more of a natural taste" (19 female, Dutch). "Not that comfortable cooking with tofu, but I've eaten outside so. [SEP] And I don't know how to cook tofu." (19 female, Indian).

5.3.1.4 Cooking with vegetables and mushrooms Acceptance

All the participants except 2 discussed the convenience of cooking with vegetables and mushrooms. They were the most convenient PBMA and were mentioned to replace meat and were considered flexible. "I actually don't like cooking a lot see So that's when I cook I most of the times make something with vegetables

and I actually want to prevent meat because I don't like making me because it's hard and takes a lot of time. So, I actually do a cook with a lot of vegetables." (19 female, Dutch). "if you need to make something like make a food, I don't think this will be enough. With Vegetables and mushrooms you can cook Any kind of dish you want.. I even put mushrooms in my instant noodles" (19 female, Indonesian). "I do cook with like I I do make a lot of recipes out of vegetables so I use it very on a day to day basis." (19 female, Indian). Some of them do not cook that often or with a selective few but still choose to cook with vegetables. "Depends on what kind of vegetable. So, like potatoes or broccoli is easy, but something like a beetroot. I wouldn't know what to make of it for a meal." (19 male, Indian). "I don't use them quite as often, but they are pretty good to cook with if I remember correctly, for my experience." (19 female, Dutch).

Non-acceptance

Cooking with mushrooms was difficult for two of the adolescents due to lack of knowledge of recipes and cooking skills. "I have cooked with mushrooms. Meaning just add in boiling water or add in soups but I don't know exactly if its cooked or not everytime" (21 male, Cambodian). Although one of the participants did not cook with any alternative at all.

5.3.1.5 Cooking with nuts and seeds/algae/jackfruit/oat flakes Acceptance

Nuts and seeds were not considered as meat replacers but those who did not eat meat at all consumed it often in their diets and included them in their recipes. "Mashed potatoes with nuts and sometimes even lasagna." (19 female, Dutch). "nuts and seeds. I usually make it with my salads" (19 female, Indonesian). "We actually prepare a chutney (spicy nuts paste) out of it. So I've had it in that way and then on a day to day-to-day basis, I soak it and then eat it but not with the intention to replace it with meat" (19 female, Indian). Oat flakes were a breakfast choice for a few adolescents due to its convenience and popularity. "oats also just need to add water and milk And you have a good breakfast. A good hot Breakfast. So since I can cook with these know how to use them and am familiar with them, I feel these are good plant-based meat alternatives" (19 female, Indonesian). "I had my period when I think it was like a time in my life I was, I wanted to become like an Instagram influencer. So I tried like all the oat flake recipes that existed. So I experienced a lot of oat flakes" (19 female, Dutch).

Non-acceptance

The least used PBMAs were jackfruit and algae. No participant mentioned using jackfruit as a PBMA and only person talked about algae with rice in a recipe.

5.3.3 Influence of cooking class Positive effect

The cooking class group consisted of people with low cooking skills (P17, P11) and/or low knowledge (P21), high cooking skills (P4) and/or high knowledge with low cooking skills (P5) based on the self-assessment of cooking skills and other knowledge questions in "general questionnaire" in Phase 1 and analysis of scores in Phase 2. The positive effect of intervention was seen among participants with low cooking skills (n=3) which were self-expressed during the interview and also when asked about the effect of cooking class. The questions regarding cooking skills with specific PBMA were also asked and analyzed. An overview of cooking class influence can be found in the table below.

P.No	Knowledge: Self- expressed /Questionnaire analyzed/ both	Phase 1question analyzed	Participant's answer in Phase 1	Interview question analyzed	Participant's answer in interview (post- intervention)
Р5	Both	How would you rate your cooking skills of Soaking and/or cooking with legumes and beans? [extremely bad (1) to extremely good (5)]	Moderately good (4)	How comfortable are you cooking with legumes and pulses?	It's like it really doesn't take that much effort and like how we did in cooking class, we chop the vegetables and just add legumes and can make the taco.
P17	Questionnaire analyzed	According to you, among the following are plant-based alternatives to meat.	tofu,tempeh,oatflakes ,vegetables (does not mention legumes and beans)	What are natural PBMA according to you? And why?	Like the taco we made yesterday at cooking class. Yeah, it was mostly with Lots of beans and Greens also
	Interview question	-	-	How did you feel about the cooking class? Do you think it helped you in any way to learn more about plant- based meat alternatives?	I thought it was An easy way to make something. Even one taco was enough to make me feel full for a really long time. And I didn't expect it to contain so much of the beans and stuff I usually think the tacos would always contain meat and stuff, but from yesterday I realized you can completely make it from plant-based meat alternatives as well

Table 6: Overview of positive influence of cooking class

P11	Both	"Plant-based meat alternatives do not provide enough energy" [strongly disagree (1) to strongly agree (5)]	agree (4)	What kind of foods do you think provide you with good enough energy to sustain throughout the day?	I experienced the benefits of the vegan tacos we made yesterday at the cooking class. I felt the energy the whole day. I felt amazing I do think if you like, combine these foods (PBMA) in your diet, they will really help you to stay energized during the day
	Interview question	-	-	How did you feel about the cooking class? Do you think it helped you in any way to learn more about plant- based meat alternatives?	it (cooking class) did give me, uh, like, what I could do with nuts. Yeah. I mean, I didn't even know they use nuts in tacos. I learned from the cooking classit did help me with like processing information about what is plant-based meat alternative and how to cook with it because I didn't know before I came to the cooking class what it was.

For those who did not cook with PBMA (n=3), it was educational in terms of ingredients and the recipes and the skills to replace meat in their meals. It was also seen that the participants identified more PBMA after the cooking class as can be seen from the responses of P17 and P5 from Table 6. Although participant P5 had cooked with PBMA before found the cooking class helpful in terms of varieties in PBMA. "*I really like the class because usually I'm very fixed on them, like, okay, I'm only going to eat tofu and tempeh and these vegetables. And sometimes I don't get that much variety*" (18 female, Norwegian/Brazilian). P11 also mentioned that they never liked using PBMA before but after the cooking class they found a way to incorporate those ingredients in the diet without having to compromise on their taste.

No effect

For the other 2 who had high cooking skills, the class did not have any effect, but they did like the variations or combinations of PBMA used which they mentioned were helpful. "*it was nice that I was just implementing a lot of different, uh, different elements. Uh, because you had a from a bunch of different sources. Mm hmm. So I like that about it.*" (21 male, Dutch). The other participant also liked the recipe in the class but expressed that he would choose meat if it tasted better.

Table 7: Overview of cooking skills with various PBMA and its influence on acceptance

РВМА	No.of participants with high and low cooking skills
Vegetables and mushrooms	High (n=14), Low (n=2)
Rice, pasta, cereals and grains	High (n=12), Low (n=4)
Legumes and beans	High (n=9), Low (n=7)
Tofu/tempeh	High (n=11), Low (n=5)
Other (nuts and	High (n=7) (cooking with nuts and oat flakes),
seeds/algae/jackfruit/gat flakes)	Low (n=16) (never used jackfruit and algae as
seeus/uigue/juckj/uii/oui jiukes)	meat replace)

Table 8: Key themes in factors for acceptance of plant-based meat alternatives

Key themes in the acceptance of PBMA	No.of participants
Knowledge	
Health and nutritional aspects	
- Digestibility	11
- Energy source	13
- Fiber content	15
- Protein content	11
- Iron and vitamin content (B1 and B12)	10
- Non-communicable diseases	15
Animal welfare	3
Environment friendliness	8
Familiarity	
High familiarity	9
Family and culture	5
Sensory factors (taste/smell/texture)	6
Cooking skill and convenience	
General cooking skill and convenience	9
Cooking skills with beans and legumes	9
Cooking skills with rice/pasta, cereals and grains	12
Cooking skills with tofu/tempeh	5
Cooking skills with vegetables and mushrooms	14
Cooking skills with nuts and seeds/ algae/jackfruit/oat flakes	7

6. Discussion

The present study focused on the adolescent's perception of PBMA living in the Netherlands between the age group of 15-24 years old similar to study by Stoll-Kleemann and Schmidt (2016) which emphasized on investing the variables influencing young people's intentions to follow a PBD (PBDs are dietary habits that

minimize intake of animal-based goods, including meat, while increasing consumption of nutritionally rich plant foods, such as vegetables, fruits, and wholegrains) (Kent et al., 2021b). One of the other reasons for choosing natural alternatives over analogues in this study was because meat alternatives (chickpeas, nuts) were scored higher than meat substitutes on situational appropriateness in a study by Elzerman et al. (2021).

6.1 Influence of knowledge and cooking skills

In this research many factors are grouped under the knowledge category influencing the acceptance of PBMA which include the participant's knowledge on health benefits of PBMA, availability, animal welfare, cost and environmental friendliness while these factors are examined separately in other papers. The reason for grouping them under one category is based on participant's responses which reflected the amount of knowledge and awareness on these subjects and hence the effect on their acceptance or rejection of PBMA. Adolescents who had chosen a vegan/vegetarian diet and completely avoided meat displayed most knowledge on PBMA and its acceptance and others who had knowledge did not entirely accept PBMA due to other factors like meat likeliness, taste, familiarity etc.

A high knowledge about fiber content and benefits of PBMA in treating non-communicable diseases like high cholesterol and high insulin was observed in adolescents along with mentions of completely avoiding meat in the latter case which was also reported from a general consumer study where plant-based foods were been linked to a variety of health advantages particularly fruits and vegetables, were linked to a lower risk of chronic noncommunicable diet-related diseases. The majority of participants (males 44% and females 50%) in a study by Munialo and Andrei (2023) also agreed that dietary fiber from a plant-based diet is beneficial to health by making statements like "Good for gut health," "Improves digestion and bowel movement, which was also the case in the present study.

Most adolescents in the study accepted PBMA as a good protein source, but many of them were also not convinced enough to replace meat entirely due to their lack of knowledge which was reported also in a study done on Australian adults who were reluctant to reduce their meat consumption due to health concerns about lacking protein and dietary nutrients normally obtained from meat (Bogueva et al., 2017). Another study also showed that despite understanding the importance of a healthy diet and the role of nutrient-rich plant-based foods, young people have expressed some health concerns about consuming PBDs (McInnes et al., 2023b). Ensaff and colleagues (Ensaff et al., 2015) also found that adolescents consider healthy plant-based foods as being less tasty than animal-based products, lack knowledge of plant-based diets, and are largely unaware of the potential benefits of consuming more plant-based foods which was not entirely the case in the current study as adolescents portrayed good knowledge on fiber, protein, digestibility, micronutrient content and environment friendliness of PBMA (Table 5).

Environmental concerns about meat consumption have shown to be a motivation for people to embrace vegan and vegetarian diets (Mullee et al., 2017; Schenk et al., 2018). However, only a few researchers have investigated whether environmental concerns affect young people's inclinations to use a PBD (plant-based diet). But in the current study it can be seen that half of the adolescents had good knowledge of the environment friendliness of PBMA and even though they were not supportive of a few practices, it still did not affect their acceptance of PBMA. In one of the studies (Ensaff et al., 2015), the main drivers identified by adolescents revolved around animal welfare, with a focus on meat which is quite contrasting to the current study where animal welfare knowledge was only discussed by a very few adolescents, but it was one of the most crucial factors for them to choose PBMA. It was also the case that the present study did not

specifically ask about animal welfare under the main question, but it was self-reported by participants as one of the factors for acceptance of PBMA over meat.

Adolescents with high cooking skills replaced meat with vegetables, mushrooms, legumes, pulses, although some found it a little difficult to cook with legumes and pulses but overall, they were convenient to cook with. Nuts and seeds were not really seen as an ingredient to replace meat but more of a snack although the knowledge of its nutritional benefits could be seen in all the discussions. The same can be observed in a study among participants with more confidence and cooking experience substituted meat for legumes, lentils, and tofu in their diets (Kemper & White, 2021). The reasons for not accepting PBMA due to cooking skills was also because some thought it was convenient to cook with meat like the participants in a study by Kemper and White (2021b) where a few were also concerned about nutrients or variety in their diet. As a result, these participants were unwilling to compromise on the perceived characteristics of meat.

6.2 Influence of cultural familiarity, food environment and childhood eating habits

Food products' acceptability is greatly influenced by familiarity. Prior research has demonstrated that consumers' perceptions and acceptance of a food product are influenced by their familiarity with it (Nacef et al., 2019) and that adolescents prefer to stick to familiar foods or those that looked like of the kind of food they were familiar with (Ensaff et al., 2015). Asians for example had greater familiarity with and visual liking for foods that originated in their own cultural spheres in a study on ten foods (including dried tofu), indicating that high consumer familiarity with a product can positively affect its liking score (Torrico et al., 2019). This can be seen in both acceptance and non-acceptance of PBMA in the study with specific focus on adolescents which shows a similar result where there was acceptance of tempeh by Asians due to high familiarity but had never heard of seitan while the Europeans were aware of it indicating a high knowledge and familiarity. Interestingly literature also shows that although tofu, tempeh, and seitan are now widely considered as meat alternatives, they are not traditionally seen as meat substitutes in their countries of origin which is the east of Asia where the consumption goes back several centuries (He et al., 2020). In this study it could be seen that the families from meat eating culture were seen to stick to their meat diets and participants were not encouraged enough to adapt PBMA in their home countries or at home while it was seen to be easier to replace meat when they moved to a more accepting environment which had people with high familiarity. Larger conservatism predicts a greater risk of reverting to eating meat after having been vegetarian, which is partly explained by lower sentiments of social support and weaker social justice reasons (i.e., worries about animals, the environment, and world hunger) (Hodson & Earle, 2018). Effect of societal pressure can also be seen in a study (Fresán et al., 2020) conducted on the participants from Denmark and California occasionally, or more frequently in the case of Denmark participants, compromised their nutrition due to societal pressure. As a result, they stated that they would consume more plant-based goods if their friends followed a similar diet. The majority of individuals in both locations said that their friends and family ate a different diet than they did, with the omnivorous diet being the most common. Hence, friends and the surrounding environment played a more significant role in accepting PBMA than family members. Sensory properties were highlighted as one of the most influential factors determining eating behavior, with texture being shown to be a major reason for rejecting or accepting food in children. The low intention to consume more plant-based food options was explained by the perceived (or expected) poor taste of these foods (Havermans et al., 2021b). Repeated exposure to food generally enhances acceptance and preference for that food (Fildes et al., 2014). Therefore, enhancing familiarity with plant-based foods is crucial for fostering their acceptance, particularly among adolescents

who may still exhibit some degree of food neophobia compared to adults (Nicklaus et al., 2005). In this study it was found that, a familiar texture and taste have been the major factors to influence the acceptance of certain PBMA while smell was off-putting for a few and the same ingredients which were accepted for texture and taste were rejected by a few. There is not enough literature to support these observations for natural or traditionally processed alternatives among adolescents which could also be one of the topics for further research.

6.3 Influence of intervention methods

The intervention method used in this study was providing a knowledge card and cooking class to examine the change in perception. A method like this has not been seen in earlier studies. Although here it was shown that providing information and educating participants on PBMA positively affects acceptance. This also displayed willingness among adolescents to make changes in their choices if the received knowledge is right. The same applied to cooking class intervention where the general notion of cooking with PBMA being difficult changed in almost all participants and were eager to try and replace meat with PBMA after the class.

7 Limitations and future recommendations

A larger no.of participants would give a better understanding of the knowledge, familiarity and cooking factors on acceptance of PBMA as a sample size of 16 is way less and 5 members in each group for intervention is not enough to under attitudes toward acceptance or rejection of PBMA. Although the present showed a difference, it may give different results in a larger population as most consumer studies are done on a larger scale. A broader horizon can also be explored in terms of the diversity of the participants. There is diversity in Nationalities and differences between gender is also something that can be further studied. Even though the intervention methods resulted in a positive effect on acceptance of PBMA, this method could be verified on a larger scale. The knowledge card used in the intervention could also be more elaborate and informative suiting to the age of the subjects, which could probably have a better impact. This suggestion is based on a participant's feedback on the card that the information was too basic and that he/she needed more concrete knowledge to accept a change in their diet.

8 Conclusion

The study delved into adolescent perceptions of Plant-Based Meat Alternatives (PBMA) in the Netherlands, focusing on the 15-24 age group. While similar research has explored factors influencing plant-based diet (PBD) adoption, this study uniquely examines PBMA acceptance. Notably, it highlights the knowledge and cooking skills of the participants' varied knowledge levels which influenced PBMA acceptance. Those knowledgeable about health benefits and cooking skills displayed higher acceptance. With respect to environmental Concerns, a positive was seen on PBMA acceptance, outweighing concerns about meat alternatives. Familiarity with plant-based foods, influenced by cultural backgrounds and social environments, significantly affected acceptance. Peer influence was pivotal. The intervention methods of introducing knowledge cards and cooking classes positively impacted PBMA acceptance, suggesting educational interventions' efficacy. In conclusion, a better education needs to be provided to adolescents with more research on PBMA. An in-depth analysis of their behaviors and social surroundings is also to be observed to understand their likes, dislikes and values they associate with PBMA. More importance is also needed in providing and improving cooking skills by encouraging adolescents in the kitchen. They can either be motivated to prepare their own meals with family and friends' support and provide easier recipes or regular cooking classes in the school environment.

Appendix

1. Pictures of PBMA chosen in the study



2. General questionnaire

https://qualtricsxmbrvypnqw3.az1.qualtrics.com/jfe/preview/previewId/8d50e7b6-678c-4d70-b9a5b2f3572ddfad/SV_74AotM5jfewC2Jo?Q_CHL=preview&Q_SurveyVersionID=current

Perception of plant-based meat alternatives	³ [°] Q [−] ExpertReview score Fair	
Socio-demographics	*	
What is your age?		
oz What is your gender?	*	33.01/2024, 11:39 Edit Survey I Qualitrics Experience Management
Female Male Other		Which of the following best describes your current dietary practice? Omniver (re-specific det) Vagestation (re-meat and fiel) Vagestation (re-specific det)
оз What is your level of education? О чиво	*	Prestariar congression with doctationary west of ten Other Traject from library Add new question
 HAND MBD VWD HBD 		Add Block
O Other		Product Knowledge and acceptance Page Break
Q4 What is your nationality?		a7 According to you which among the following are plant-based alternatives to meat_(choose all that apply) Legenes Mathemas Thu Thu
Q5 Are you fully or partly responsible for the household groceries? Vies, always responsible Vies, whard responsible Not at all responsible	*	Interpret Out falses Out falses Arges Judds and all seeds Arges Juddshift (paths.egglam) Setavahreat protein

						:0: -+	
н	。 ow would you rate t	the statemen	tements below?				
		strongly disagree(1)	disagree(2)	not sure(3)	agree(4)	strongly agree(5)	
(Combination of legumes and grains is a good eplacement for meat in your meal	0	0	0	0	0	
1	Nuts have sufficient iron and Vitamin B1 to substitute meat	0	0	0	0	0	
1	A good meat alternative should be low in aturated fat, salt and no added sugar	0	0	0	0	0	
F	Plant-based foods have high fibre content	0	0	0	0	0	
1	/itamin B12 can only be obtained from animal	0	0	0	0	0	
l I I I I	Consumption of egumes and other plant-based foods are used to treat non- communicable diseases like blood cholesterol used length temption	0	0	0	0	0	

How would you rate to (Note : Plant-based a legumes, nuts, beans and not ready-to-eat	he statemen Iternatives ti , etc or tradi products like	its below? o the meat h itionally proc a vegan chick	ere are nati essed prod ken nuggets	ural whole f ucts like tof vegan bee	oods like u/tempeh f)
	strangly disagree(1)	disagree(2)	not sure(3)	agree(4)	strongly agree(5)
You cannot get enough protein on a plant-based diet	0	0	0	0	0
Plant based meat alternatives are difficult to prepare	0	0	0		0
Plant based meat alternatives are difficult to digest	0	0	0	0	0
Plant based meat atternatives are not filling	0	0	0	0	0
Plant based meat alternatives are not available	0	0	0	O	0
Plant-based meat alternatives do not provide enough energy	0	0	0	0	0
Plant-based meat alternatives are a source of fiber	0	0	0	0	0
Plant-based meat alternatives are environmentally friendly	0	O	O	0	0
Q10					*
Where do you learn a apply)	ibout plant-b	ased meat a	alternatives	from? (cho	ose all tha
Friends/family					
🗇 School (teacher or textbo	icks)				
🗆 Social media (Instagram.	Facebook, Tik-to	RQ.			
Search engines (such as	grogie)				
Food company websites					
Government websites					
Others namely					

1/2024, 11:39	Edit Survey I Qualtrics Experience Management					
	011 *					
	How often do you consume meat during the main meal?					
	Seldam/never					
	O Once per month					
	O 2-3 times per month					
	O Once per week					
	O 2-3 times per week					
	O 4-6 times per week					
	C 1-3 times per day					
	012 *					
	How often do you consume plant-based meat alternatives in meal?					
	O Seldom/never					
	O Once per month					
	Q 2-3 times per month					
	O Once per week					
	O 2-3 times per week					
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	Q14					Ý *
	How willing are you meat?	to try these p	roducts in y	our meal as	an alternat	ive to
		Not at all willing(1)	Slightly willing(2)	Moderately willing(3)	Very willing(4)	Extremely willing(5)
	beans/lentils	0	0	0	0	0
	grains (maize, wheat, rice, quinoa)	0	0	0	0	0
	mushroom	0	0	0	0	0
	nuts and seeds	0	0	0	0	0
	tempeh/tofu	0	0	0	0	0
	seitan (wheat gluten)	0	0	0	0	0
	Q15 How willing are you	to replace me	at with the	se products i	n vour mea	Ý *
						A.1
		Not at all willing(1)	Slightly willing(2)	Moderately willing(3)	Very willing(4)	Extremely willing(5)
	beansilentiks	Not at all willing(1)	Slightly willing(2)	Moderately willing(3)	Very willing(4)	Extremely willing(5)
	beans/lentils grains (maize, wheat, rice, quinoa)	Not at all willing(1)	stightly willing(2)	Moderately willing(3)	Very willing(4)	Extremely willing(5)
	beansflentils grains (maize, wheat, rice, quinca) mushroom	Not at all willing(1)	slightly witing(2)	Moderately willing(3)	very wiling(4) C	Extremely willing(5)
	beansflentils grains (maize, wheat, rice, quinca) mushroom nuts and seeds	Not at all willing(1)	slightly willing(2)	Moderately willing(3)	very willing(4)	Extremely willing(5)
	beansflembs grains (maize, wheat, rice, quinca) mushroom nubs and seeds tempeh/tolu	Not at all willing(1)	slightly willing(2)	Moderately willing(3)	Very willing(4)	Extremely willing(5)
	beansitentis grains (maize, wheat, dce, quinoa) mushroom nuts and seeds tempehitolu seitan (wheat gluten)	Net at all. willing(1)	slightly willing(2)	Moderately willing(3)	Very willing(4)	Extremely willing(5)
	beanstenits grains (maize, wheat, doc, quinca) mushroom mushroom nuts and sends tempeh/totu seitan (wheat gluteri) Q16	Not at all willing(1)	Slightly witting(2)	Moderately willing(3)	Very willing(4) C C C C C	Latremely willing(5) O O O O O O
	beanstends grains (maize, wheat, nice, quinca) muthream nuthream nuthand sends, tempehtodu seatar (ohear gluterr) 016 How likely are you to grocery list weekly n	Not at all witing(1)	slightly willing(2) C C C C C C C C C C C C C C C C C C C	Moderately witing(3)	very wiling(4) C C C C C	Extremely willing(5) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	bears/lent/s grains (maize, wheet, rice, quinca) mutaroom mutaroom mutaroom mutaroom mutaroom mutaroom mutaroom mutaroom sector sector file Mow likely are you to file Mow likely are you to grocery list weekly in O to terremely untilety	Not at all willing(1)	sligtty witing(2)	Moderately witing(3)	very willing(4)	Extremely willing(b)
	beanstends grain (naite, sheat, naite, quinca) muthecen naite and seeds: tempeh/tal. seater (wheat guten) 016 How likely are you to grocery (tist weekly n © Externet unikely	Not at all willing(1)	slightly witing(2)	Moderately witting(3)	very willing(4)	Extremely willing(6) 0 0 0 0 0 0 0
	beanstends grains (initiae, wheat, rice, quinca) mutaream mutaream mutaream mutaream setter (onear gluter) costs How likely are you to grocery list weekly in correctly unitely costs unitely costs unitely on united	Not at all willing(1)	slighty wiling(2)	Moderately willing(3)	very willing(4)	Ltromety willing(5) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

2024, 11:39	Edit Survey Qualines Experience Management					
	Q17 *					
	Where have you had the chance to try plant-based meat alternatives? (choose all that $\operatorname{app}(y)$					
	At home					
	In a restaurant					
	On the go					
	At school/work					
	Have not tried yet					
	Others (please mention)					
	-					
	What do you make from these plant-based meat alternatives? (choose all that apply)					
	Stews					
	Pasta					
	Soup					
	Salad					
	Bread					
	Rice dishes					
	Potato dishes					
	Food to imitate meat					
	Other (mention if any)					
-	Import from library Add new question					
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ooking skills	
Q19	*
How long do you spend on cooking on average in a day?	
O 5 - 10 minutes (heating in the oven, microwave, air fry, make a toast)	
O 20-30 minutes	
O 1-2 hours	
O I do not cook	

	life did vou	learn most	of vour cook	ing skills?	
As a shild (under 12) mar	and you	iourrinoor.	or your cook	ing states.	
As a teenager (13–19 ver	ene)				
After 19 years of age					
 I do not know how to coo 	k				
Q21					*
Vo Ves	n-based iou	u as auterna	10463 (0 1166		s, tegunies,
Q22					ý *
How would you rate y	our cooking	skills?			
	Extremely bad(1)	Moderately bad(2)	Neither good nor bad(3)	Moderately good(4)	Extremely good(5)
1 Chop, mix and stir foods	0	0	0	0	0
2 Boil or simmer	0	0	0	0	0
3 Roast food	0	0	0	0	0
4 Fry/stir-fry food in a frying pan/wok with oil or fat using gas	0	0	0	0	0
5 Peel and chop vegetables (including potatoes, carrots, onions)	0	0	0	0	0
6 Soaking and/or cooking with legumes and beans	0	0	0	0	0
7 Cooking with nuts and oil seeds like sesame, groundout, sunflower	0	0	0	0	0
seeds, pumpkin seeds, etc.					
seeds, pumpkin seeds, etc. 8 Cooking tempeh/tofu	0	0	0	0	0
seeds, pumpkin seeds, etc. 8 Cooking tempel/tofu 9 Cooking with mushroom	0	0	0	0	0
seeds, pumpkin seeds, etc. 8 Cooking tempeh/tofu 9 Cooking with mushroom 10 Cooking with rice, pasta, quinoa and other cereals and grains	0	0	0	0	0

3. Knowledge card



4. Cooking class : ingredients used and the participants involved.







5. Recipe for the cooking class

Ingredients: Jumbo dip guacamole, bond.black beans, sanmar taco sauce, bond. Mexico blend, sanmar seas taco, Jozo table salt, jumbo pepper black, jumbo red onions, red tomatoes cherry, sanmar taco shells, coriander and Lettuce

Instructions:

- 1. Chop the onions, tomatoes and coriander and add it a bowl
- 2. To this mixture add the canned beans and Mexican blend of corn and capsicum, taco sauce, seasonings, salt and pepper.
- 3. Chop the lettuce and nuts
- 4. On the taco shell, put lettuce, guacamole and the mixtures of beans and spices above along with nuts on top

6. Interview guide

Interview questionnaire quide

Introduction

(An informal introduction with the participant)

Firstly, thank you for taking part in the study.

Interviewer introduction: I am a 2nd-year master's food technology student, and I am currently doing my thesis. I aim to understand adolescents' perceptions of plant-based meat alternatives. The interview will take about 30 minutes. I will ask a few general questions regarding your perception of plant-based alternatives. There are no right or wrong answers. Feel free to interrupt at any point if you have any questions.

Consent

Would you be okay if I audio-recorded this conversation only for the research and your identity shall remain anonymous?

Interview

The definition of PMBAs that we will be talking about during this study is: Plant-based meat alternatives are natural whole foods like legumes, nuts, beans, etc, or traditionally processed products like tofu/tempeh and not ready-to-eat products and meat analogs like yegan bicken nuggets/vegan beef. Nuts and beans are eaten as an addition, not a replacement but are still under the category of alternatives due to nutritional benefits.

- 1. What do you understand by plant-based meat alternatives? Can you give a few examples? How do you know about them? 2. Have you tried PBMAs (by PBMAs I mean whole natural foods and not processed
- products or analogs as a replacement for meat in your meal)? Do you like them? why/why not?
- 3. Currently, what are the factors for you to not choose plant-based meat alternatives? why/why not? 4. What other factors according to you would encourage you to choose plant-based
- meta alternatives? why/why not?
 Which among these do you see as PBMAs? Why do you see these as alternatives and why not others? legumes, mushrooms, tofu, soya beans, tempeh, seitan/wheat protein, oat flakes, vegetables (potato, eggplant), nuts, algae,
- activit?
 How often do you consume plant-based meat alternatives in a meal downative wheely wheely activit?
 How often do you consume plant-based meat alternatives in a meal downative wheely activity and the activity of the activ daily/week/month? why/why not?
- 8. How do you think you get enough protein in your diet/where do you think you get your protein from? Why?
 9. Do you think ruls have sufficient iron and vitamin B1 to substitute meat? why/why
- not?
- 10. What properties do you think a good plant-based meat alternative should have? why/why not?
- 11. What food sources do you think have high fiber content? why/why not? 12. Where do you think you obtain Vitamin B12 from? What meal components? Why do you think so?

- 13. What kind of food do you think people with non-communicable diseases like blood cholesterol and insulin levels should consume? why/why not?
- 14. What is your understanding of the digestibility of PBMAs? why/why not? 15. What kind of foods do you think provide you with enough energy? why/why not?
- 16. What is your opinion about the environmental friendliness of plant-based meat alternatives? why?
- 17. Where do you learn about plant-based meat alternatives from? Do you think that information is sufficient?
- 18. Which source do you trust the most/rely on to learn about PBMAs? Which information source do you use now? why?
- 19. How willing are you to try these plant-based meat alternatives as a replacement for meat in your meal? why/why not?
- 20. How willing are you to replace meat with these plant-based meat alternatives in your meal? why/why not?
- 21. How likely are you to purchase plant-based meat alternatives regularly on your grocery list weekly right now? why/why not?
- 22. What is your opinion about the cooking convenience of PBMA? why/why not? 23. What kind of dishes do you prepare from these plant-based meat alternatives? which ones do vou like the most? -
- 24. How comfortable are you cooking with legumes? why/why not?
- How comfortable are you cooking with vegetables? why/why not?
 How comfortable are you cooking with nuts and seeds? If so, how good are you at it? why/why not?_____ 27. How comfortable are you cooking with tempeh/tofu? why/why not?
- 28. How comfortable are you cooking with mushrooms? why/why not?
- 29. How comfortable are you cooking with rice, pasta, and other cereals and grains? -30. Would you choose plant-based meat alternatives if you had more knowledge about it? why/why not?
- 31. Would you choose to cook with plant-based meat alternatives more if you were taught more recipes?
- 32. How did you feel about the knowledge card/cooking class? Do you think the knowledge card/cooking class helped you in any way to change your perspective towards PBMA? Thank you for your time. Do you have any questions?

The amount for participation will be transferred to your account so I request you to fill in the account details kindly.

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