



Research report

Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution

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ABSTRACT

The shift towards a more sustainable diet necessitates less reliance on foods of animal origin. This study presents data from a representative survey of Dutch consumers on their practices related to meat, meat substitution and meat reduction. The practices reflected a cultural gradient of meat substitution options running from other products of animal origin and conventional meat free meals to real vegetarian meals. To investigate feasible substitution options, a variety of meals without meat were presented using photos, which were rated by the participants in terms of attractiveness and chances that they would prepare a similar meal at home. The results demonstrated the influence of meal formats, product familiarity, cooking skills, preferences for plant-based foods and motivational orientations towards food. In particular, a lack of familiarity and skill hampered the preparation of real vegetarian meals. Based on the findings we propose a diversified understanding of meat substitution and we specify four policy-relevant pathways for a transition towards a more plant-based diet, including an incremental change towards more health-conscious vegetarian meals, a pathway that utilizes the trend towards convenience, a pathway of reduced portion size, and practice-oriented change towards vegetarian meals.

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Introduction

The high consumption of animal based proteins, especially meat, has been identified as one of the most relevant topics to be addressed if Western consumers are to shift towards a more sustainable diet (Leitzmann, 2003; Pimentel & Pimentel, 2003; Reijnders & Soret, 2003; Stehfest et al., 2009, Stehfest et al., 2006). The scale and intensity of animal production generates an increasing proportion of global environmental pressure, including climate change. Stehfest et al. (2009) point out that the large impact of the livestock sector on climate change is regularly overlooked, while a global transition towards low-meat diets, which are also desirable for health reasons, may reduce the costs of climate change mitigation by as much as 50% in 2050. In Western countries such as the Netherlands, where meat consumption has been stabilizing around 86.7 kg (meat with bones) per capita per year (PVE, 2010), the main goal needs to be a (partial) substitution of proteins of animal origin by plant proteins (Aiking, 2011; Gernbens-Leenes, Nonhebel, & Krol, 2010; Smil, 2002). Due to the overall popularity of meat and the great variety of factors that influence food patterns, however, it may take a profound societal transition to achieve this goal. Although the need for a substitution has

frequently been advocated, only few studies have discussed consumer readiness and willingness to eat a more plant-based diet (de Boer & Aiking, 2011; Elzerman, Hoek, van Boekel, & Luning, 2011; Lea, Crawford, & Worsley, 2006; Wansink, 2002). The present paper examines survey data from Dutch consumers on their practices related to meat, meat substitution and meat reduction in order to identify some feasible pathways for a transition towards a more plant-based diet.

One of the ways to study pathways for a transition is to look at the changes of the recent past. This perspective is crucial to better understand meat's special status (deFrance, 2009; Fiddes, 1991) and the interrelated character of continuity and change in food consumption, which underlies the structural aspects of meals (Mennell, Murcott, & van Oterloo, 1992). Other relevant literature to consider includes the lessons drawn from effective, protein-related dietary changes (Wansink, 2002). According to psychological motivation theory (Ryan & Deci, 2000), the essence of making effective changes is that new practices must be to some degree congruent with the rest of the behavior of the consumer. In other words, the range of meat-free options that are currently available should match the practices and the motives of consumers who may be ready to adopt a particular option. Finding those matches is an important step to identify potential pathways, as will be shown in the next sections.

A key strategic point is that meat's special status can be distinguished from its mass consumption. Although complex societies

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throughout history made use of animals and their meat to provide food, to establish social distinctions as wealth and status and to foster social unity through the symbolic manipulation of animals in ritual (deFrance, 2009), the upsurge in consumption of meat is a relatively recent phenomenon. The food historians Teuteberg and Flandrin (1999) and the geographer Grigg (1995) have noted that the transition from cereal protein¹ (i.e. bread) to animal derived protein in Europe was finalized only after World War II. Nevertheless, most Western European countries belonged to the group of major meat consumers already before that, which may have paved the way for the steep increase that followed. Today, meat consumption is the result of a chain of industrial activities that produce highly standardized meat products, commonly sold in supermarkets and de-animalized to avoid reminding customers about the link between the meat dish and the killing of an animal (Vialles, 1994). Hence, it is not meat's special status that has to be the primary focus of change efforts, but its heavily routinized consumption, which accounts for the sheer volume of meat.

The main reason why meat's special status still needs attention is that it is closely connected to the structural aspects of meals. The well-known anthropologist Mary Douglas (1972) has shown that meals follow an underlying system of rules, which amounts to a grammar comparable to that of a language. She identified persistent *trans-cultural* hierarchies of people's valuation of foods, in which meat ranks highest, followed by fish and then other animal derived products (Douglas & Nicod, 1974). Also, she showed that meals typically consist of a tripartite structure of meat/fish, a staple and one or two different vegetables. As the research of Douglas was conducted in the 70s of the previous century, it is an open question to which extend these patterns are still in place. Even if they are not, however, these patterns are likely to have influenced consumers who have grown up in this era. It is also important to consider that Douglas' research was conducted in the United Kingdom and applies typically to Western European countries. Her findings might not easily translate to Chinese or Indian food culture where meals are composed in an entirely different manner. The Netherlands, however, fit in well with Douglas' findings. A commercial study that surveyed 5000 households in 2005 shows that their meals had a quite consistent tripartite structure of a staple, a vegetable and a protein component, typically meat. More precisely, on the day of the fieldwork (i.e. a Wednesday) 52% consumed potatoes (boiled or mashed), 86% used a vegetable and 86% prepared meat (Knorr, 2005). Yet, Italian and Asian dishes were also served, which may indicate an incremental change of meal patterns towards new meal formats.

The role of meal formats in cultural continuity and change can be seen in many historical examples of changes in dietary habits. In the past, substitution of particular foodstuffs was often a superimposed change of eating habits due to scarcity and limited choices. According to the historian Montanari (1994), transitions in food consumption patterns usually happen by way of substitution with a food that can take over the function of the foodstuff that fell away. The same replacement rules are relevant for planned changes, for instance, when unfamiliar foods can be introduced by combining them with existing foods. An example occurred during World War II, when US citizens were encouraged to incorporate protein-rich organ meats into their protein-deficient diets (Wansink, 2002). Obviously, efforts to change eating habits require a thorough understanding of consumers' responses in terms of food acceptability, and food preparation and serving methods. In drawing lessons from the recent history of dietary changes, Wansink (2002) notes that, in its most basic form, an acceptable food must be available; must taste good; must be familiar; and must look, taste, and feel as expected.

To achieve a partial substitution of animal-based proteins by plant proteins a variety of options is currently available. It should be noted, however, that many conventional Western meat-free dishes contain other animal-based products such as fish, eggs, cheese or other dairy products. From a sustainability perspective, these products offer not much advantage compared with meat (de Boer & Aiking, 2011). Other popular options are stir-fries and pasta dishes, which may have slightly neutralized the role of meat as a centrepiece on the plate, such as in the Mediterranean diet (Montanari, 1994). Also, there are various possibilities to prepare meals without animal-based products. Supermarkets in the Netherlands nowadays store a variety of products that are marketed as meat substitutes. While the turn-over of meat substitutes grows steadily, absolute market share is still low by about 1% of the market for meat and meat products (Aurelia, 2002). Still, 36% of households have been reported to purchase meat substitutes occasionally (GfK Panel Services Benelux, 2009). The products are sold as burgers, stir-fry cubes or "mince-meat" and they usually derive from soybeans. The Dutch company Ojah® produces a variety of 100% plant protein substitutes that resemble the texture and bite of meat. Other products are, for example, Valess® that is based on dairy and algae or Quorn® that is derived from a fungus (Peregrin, 2002). We refer to these products as instant meat substitutes because they are marketed as such and are processed, prepared and labeled for use instead of meat. That way, consumers can easily identify them as relatively familiar alternative sources of protein. We mention tofu as a separate foodstuff because it is also sold in raw form. Earlier studies have shown that meat substitutes appeal to a wide range of consumers, above and beyond the "traditional vegetarian" market (Hoek, Luning, Stafleu, & de Graaf, 2004; McIlveen, Abraham, & Armstrong, 1999; Sadler, 2004).

In addition to the instant meat substitutes, there is extensive variety of foods containing high-quality plant protein, which include many foodstuffs that are not foreign to Dutch cooking such as beans, pulses, nuts and whole grains (McGee, 2004). It requires, however, some nutritional knowledge, some knowledge of preparation and an adjustment of personal food habits to use them. Hence, it is highly unlikely that the majority of consumers are aware of the large variety of plant protein sources (Lea et al., 2006). Organic stores that usually cater for specific consumer segments store many plant protein sources in pure form and some instant substitutes derived from these sources (i.e. lentil or falafel burgers). The stores are often prepared to serve customers with vegetarian, macrobiotic or anthroposophical diets, which entail food styles that are less geared towards the consumption of meat to begin with. Instead of substitution, the products offered are simply aimed at providing a healthy source of (plant) proteins.

Last but not least, insects are being considered as a potential replacement for animal derived proteins (Vogel, 2010). Some organizations currently lobby in the Netherlands for the use of insects for human consumption and some stores have already included mainly locusts and mealworms into their assortment. The insects are marketed as a delicacy and can be ordered in some restaurants and some Internet shops specializing in exotic (meat) products. The consumption of entire insects, as we know it from many Asian and African countries, still seems unlikely to take over the West, as reminders of livingness or of particular textures may trigger aversion (Martins & Pliner, 2006). Therefore, scientists currently also focus on the use of insect protein in convenience products, replacing protein from other sources (Verkerk, Tramper, van Trijp, & Martens, 2007).

The broad variety of options suggests several pathways for a transition, which will be more or less different from existing eating patterns, and may or may not involve new foods. The pathways have to be targeted to consumers with different degrees of readiness and willingness to change eating habits. Their readiness to

¹ Hereafter, we refer to plant protein.

adopt a particular substitute will depend on current practices, such as preferred meal formats, product familiarity, cooking skills, and general preferences for plant-based instead of animal-based foods. Because the heterogeneity of culinary practices and beliefs regarding use of protein products may be very large (Barr & Chapman, 2002; Newby & Tucker, 2004), it is important to consider two broader motivational orientations that capture consumers' concerns with food. Using a survey questionnaire among the general population in the Netherlands, de Boer and colleagues (2007) have shown that consumers' level of involvement in food can be separated into taste-oriented and reflection-oriented motivational goals. Both of them are relevant in the present context. The first orientation includes the cultivation of an adventurous taste, which contrasts with the opposite pattern of preferences for an ordinary meal. As far as plant-based meals increase the variety of food choices, they may be attractive to consumers who are driven by an adventurous taste (Bäckström, Pirttilä-Backman, & Tuorila, 2004; Ullrich, Touger-Decker, O'Sullivan-Maillet, & Tepper, 2004). Insects may also be attractive to consumers with an adventurous taste. The second orientation involves reflective attention to the wider implications of food choices in terms of health, naturalness of the food, weight control and ethical considerations (de Boer et al., 2007; Pollard, Steptoe, & Wardle, 1998), which contrasts with the opposite pattern of being easy about food. A reflective orientation may be associated with a preference for more plant-based proteins and relatively small portions of meat (de Boer, Boersema, & Aiking, 2009).

In sum, the paper aims to clarify attitudes towards various substitution options and identify pathways towards the (partial) substitution of meat in the future. It tries to accommodate a number of theoretically relevant distinctions, such as preferred meal formats, as well as taste-oriented and reflection oriented food-choice motives, in addition to more practical distinctions regarding product familiarity, portion size and cooking skills. A wide range of strategically relevant options will be considered, both existing and novel ones. The next section describes the design and the content of the survey on these topics.

Method

Procedure

The data set is based on a nationwide sample of 1083 consumers in the Netherlands. The very high degree of Internet penetration in this country (about 93% of the population) enabled a survey among consumers with Internet access. The stratified sample was drawn from a large panel of persons who are willing to participate in web-based research for a small fee. In November 2010, the sample received a temporary link to a survey about food (response rate 68% within 2 weeks). Due to the stratified sampling procedure, the data showed a representative distribution of the main demographic characteristics, i.e. gender (50% female), age (between 18 and 92, mean 49.5), level of education (24% primary and lower secondary, 51% upper secondary, 25% tertiary level) and place of residence. The questionnaire comprised modules with questions about practices regarding use of meat and meat substitutes, food choice motives, portion sizes, attractiveness of meat substitutes, and some household characteristics.

Meal format and food practices

The questions about meal format and food practices were single-item measures of relevant differences. The question on the preferred meal format was a choice between two photos showing a meal consisting of loose components (a cutlet, potatoes and a

vegetable arranged separately) and a meal that combines ingredients (ground meat in a pasta dish). The question was "Which of these types of meal do you prefer?" and had a dichotomous response format. Other questions asked for the number of meat eating days ("How many days per week do you eat your main meal with meat (including chicken)?") and regularly eaten kinds of meat (see below). The subject of meat substitution was introduced neutrally, without further mention of health, environmental or animal welfare motives that people might have for skipping meat in their diets. Questions included "On the days you don't eat meat, do you deliberately substitute something for it?" (The answers were "Yes" and "No"). "With what do you substitute it?" (See below.) "Do you buy meat substitutes?" ("Regularly", "occasionally", "rarely", "tried once", "no".) "Would you like to learn better how to cook vegetarian?" ("Certainly", "perhaps", "no, I am not interested", "no, I can do it already").

Food choice motives

The items on food choice motives were developed by de Boer and colleagues (2007) on the basis of Higgins' (1997, 2006) motivation theory to measure two important motivational orientations regarding food, namely the cultivation of an adventurous taste and the reflective attention to the wider implications of food choices. The items were written in terms of short, positively worded portraits of persons who show different degrees of involvement in food, both in taste-oriented and reflection-oriented ways. The female version of a taste-oriented item is: "She feels proud of her taste. She believes that her food choices are very attractive." A newly added item is "She likes many different foods. She is also a great taster." The opposite is a preference for ordinary meals. An example of a reflection-oriented item is: "She is very mindful of food. She wants to eat sensibly." In this case the opposite is being easy about food. Participants were asked to compare the portrait to themselves and to rate on a 7-point scale "how much like you" the person is. The answers were centered to correct for individual differences in average rating levels. In agreement with earlier work, the principal component analyses showed that the 12 items assessed two independent components of food choice motives, taste-oriented and reflection-oriented respectively (Cronbach's alpha .74 and .62). It should be noted that the participants were not considered to be taste motivated or reflective motivated in absolute terms; both components provide a continuum from relatively high to relatively low and the distribution of the scores did not differ significantly from a normal distribution (Kolmogorov-Smirnov test, $z = .91$ and 1.17).

Ratings of substitution options

Participants were presented with 13 photos of various vegetarian meals, which they had to consider separately. In order to harmonize the options with country specific food styles, the selection was informed by qualitative interview data collected at an earlier stage in the research and in parallel various shops were scanned for product offers. Along with more or less common options to substitute meat, the survey included one hypothetical image of a deep-freeze pizza with an enlarged ingredients list, where insect protein was highlighted. This product is currently non-existent. Thus, presently existing options were combined along with innovative future options that are currently beginning to show.

The pictures were used in order to help participants imagine novel options and overcome a possible bias of unfamiliarity with meat-free meals. Participants were asked to score separately the attractiveness and the chance that they would prepare a similar meal at home. How attractive are these meals to you? How big is the chance that you would prepare them at home, given that

ingredients are easily available? The ratings were made on a 7-points Likert scale (1 = very attractive to 7 = very unattractive; 1 = highly likely to 7 = highly unlikely).

Preferences for plant-based snacks

A four-item scale was used to assess general preferences for either foods of animal origin versus foods of plant origin, apart from the main meal. This scale was based on three questions addressing the preference for various meat or vegetarian fillings of sandwiches (shown in photos) and a question on snacks, which were animal-based (including hybrid products consisting of partly meat and partly an unspecified meat substitute) or vegetarian (including algae and lentils). The results showed a fairly consistent pattern of preferences in favor of either meat-based or plant-based food options (Cronbach's alpha .61). The emphasis was on the meat-based options, which were chosen four times by 39%; 5% chose four times the plant-based option. Choosing the plant based options correlated positively ($r = .54, p < .001$) with answers to the question "Would you like to learn better how to cook vegetarian?" Both measures reflect a positive attitude towards vegetarian options.

Portion size

The participants were shown three photos of a plate with a piece of meat that was 50, 100 or 150 g. These weights were also given in the descriptions of the photos. Each photo was accompanied by the question whether the portion size was too small, enough or too large (i.e. creating non-monotonic item response functions). After dichotomizing the responses to the 50 and the 150 g items, the three items yielded a reliable score (Guttman's Lambda 5 = .63).

Data analysis

The data on meat consumption practices were subjected to principal component analysis and multidimensional scale analysis to identify patterns that may influence judgments and use of meat substitutes. Principal component analysis was also used to define patterns in the ratings of the substitution options, which were correlated with the other variables. All analyses were conducted with SPSS 15 for Windows.

Results

Meat-related practices

The first part of the analysis focussed on meat-related practices. When asked about the main meal, the participants reported, on average, a number of 5.4 meat days per week (the median was 6). Eating meat every day was reported by 28% but 23% answered not to eat meat more than 4 days a week. The number of vegetarians was low; 1.2% of the sample indicated to be a full vegetarian or eat meat less than once a week. Consumers with reflective attention to the implications of food choices for health and environment reported a slightly smaller number of meat days per week ($r = -.17, p < .001$). Those with an adventurous taste were not different from the others. A higher number of meat days per week was correlated with a preference for relatively large portions of meat ($r = .20, p < .001$). The most preferred portion size was 100 g (versus 50 and 150 g).

Given the choice between meals that combine ingredients (i.e. ground meat in a pasta dish) and meals consisting of loose components (i.e. a cutlet, potatoes and a vegetable arranged separately)

Table 1

Meat choices and meal formats, frequencies and loadings using rotated Varimax principal component analysis.

Items ^a	Frequency (%)	Component loading	
		1	2
Regularly eats sausage	25	.75	.07
Regularly eats minced meat	74	.60	-.12
Regularly eats steak	19	-.50	-.21
Regularly eats beef cutlet	30	-.44	.20
Regularly eats pork chop	27	-.21	.67
Prefers plate of separate components	54	.07	.63
Regularly eats chicken	75	-.05	-.63
Eigenvalues		1.41	1.34

^a All items are dichotomous. Participants made a maximum of three meat choices from the list.

46% preferred the first and 54% the latter. The preference for the component meal was associated with a slightly higher number of meat days ($r = .09, p < .01$), but it was somewhat stronger correlated with choices for particular cuts of meat and with the participants' age. The participants were asked to indicate which cuts of meat they regularly eat by selecting a maximum of three from a list of popular cuts in Dutch households. A principal component analysis of the answers showed that choices for particular meat cuts were associated with each other and with the preferred meal format (Table 1). Firstly, participants who regularly eat sausages and minced meat were less likely to mention the two steak options offered in the choice set and vice versa, but all these options may fit into the same meal format. Secondly, those who were in favor of the component meal format were less likely to mention chicken and more often eat pork chop. The correlation analysis revealed that younger participants under the age of 55 years more often preferred combined meals while older participants preferred the component meal ($r = .21, p < .001$) and the pork chop ($r = .23, p < .001$) but not so much the chicken ($r = -.16, p < .001$). Hence, the data showed a cohort effect of changing meat-related meal patterns.

Substitution patterns

The participants who reported to eat meat less than 5 days per week were asked whether they deliberately replaced meat by something else. Most of them did (81%, $n = 253$), but this was less common among the older participants ($r = -.24, p < .001$), whereas household income did not make a significant difference ($r = -.10, p > .10$). The participants who said deliberately to substitute meat ($n = 204$) were asked what they used instead. They could make a maximum of three choices from a list of potential substitutes or they could indicate substances that were not specified in the list. Table 2 shows the answers to this question and the results of a multidimensional scale analysis to identify substitution patterns. The analysis produced a one-dimensional gradient that ran from fish, via eggs, cheese to instant meat substitutes, followed by lentils or other pulses, nuts, and finally seitan, tempeh and tofu. The ordering of the items shows that the most popular meat substitutes were other products of animal origin. At a general level, the gradient runs from "conventional meat free meals" to "real vegetarian meals". By conventional meat-free meals we mean meals in which meat is replaced by either other sources of animal protein, such as fish, eggs or cheese or by instant meat substitutes. The meals often maintain the conventional component meal structure. Real vegetarian meals are based on a broad variety of mainly plant proteins and a transition has taken place away from existing meal formats and food hierarchies. The idea of meat substitution has become less prominent.

Table 2

Meat substitution practices (frequencies and coordinates in multidimensional scale analysis, model = interval, data = binary, 1 dimension, normalized raw stress = .11).

Items ^a	Frequency (%)	Coordinate
Fish	76	1.24
Egg	49	.78
Cheese	34	.37
Instant meat substitutes	26	.02
Lentils or beans	17	-.24
Nuts	9	-.41
Seitan	1	-.51
Tempeh	3	-.53
Tofu	14	-.72

^a Participants who reported to eat meat less than 5 days per week and to substitute meat ($n = 204$) made a maximum of three choices from the list of nine options.

A crosscheck with the data on the number of meat days provided additional insights into the gradient model. In this segment of participants ($n = 204$), the number of meat days ranged from 4 to 0. A smaller number of meat days was associated with fewer choices of fish ($r = -.36$, $p < .001$) and egg ($r = -.12$, $p < .10$); it had a non-monotonic (rise-then-fall) relationship with choices of cheese ($r = .06$, $Eta = .24$), and was correlated with more frequent choices of instant meat substitutes ($r = .39$, $p < .001$), lentils or other pulses ($r = .17$, $p < .05$) and tofu ($r = .20$, $p < .01$). Despite this broad gradient, the patterns were more heterogeneous at a detailed level, which may partly depend on the sheer number of observations and on preferred meal formats. For instance, cheese was more often mentioned by those who were in favor of the meals that combine ingredients ($r = .19$, $p < .01$). Hence, it would be too strong to conclude that meat substitution simply followed a linear path.

Substitution options

To measure the responses of all participants to various substitution options, 13 pictures were presented to them in combination with two questions. First, they were asked to rate the attractiveness of the meal and second, they were asked to rate the chance that this meal would be served at their homes, given the ingredients were easily available. Table 3 presents the items in order of decreasing mean ratings, from the omelette to the salad with fried mealworm. The decreasing order of attractiveness was almost the same as the decreasing order of the chance that this meal would be served in their homes. In general, participants evaluated the substitution options with positive to neutral scores (from 2 to 4 on the 7-points scale). Except for Seitan, the first 8 items on the list are relatively well known edibles, while Indian Daal is slightly more exotic and as a dish possibly unknown to most participants. In contrast, the photos of meals with visible insects were rated much more negatively. A relative exception was the protein derived from insects and processed in pizza, which was evaluated less negatively than the other insect dishes. Another less negative rating compared to the fully visible insects was given to the chocolate-coated locusts.

The principal component analysis was computed on all the ratings, except those for the omelette, which was just a marker for the use of the rating scale. The scree plot suggested four components, which captured 67% of the variance. Table 3 presents the loadings of the substitution options on the following components:

1. Tofu stir-fry, a tofu snack, Seitan stir-fry, Tivall minced in sauce and Tivall vegetable steak.
2. All dishes with visible insects.
3. Indian daal, Moroccan couscous, Pasta pesto with nuts.

4. Pizza with protein of insects.

The four components suggest some interesting underlying orientations of the participants. The first component consists of options where meat is deliberately substituted. The photos depicted meals with substances that imitate the role of meat, while leaving no doubt about it being a substitute. A positive rating seems the choice of people who accept and utilize the concept of meat substitution. For ease of reference it is called here the soy-adapts component.

The second component consists of all dishes with visible insects, including the chocolate-coated locusts that are still recognizable as insects. The loadings reflect a clear common theme, namely the unanimous rejection of insects as an attractive food-stuff. It is called here the insects component.

The third component consists of substitution options that are not necessarily eaten to deliberately substitute meat. It is a component that represents an incremental change towards a more vegetarian meal style, which often implies integrating or merging Dutch cooking with more exotic or foreign cuisines. It is called here the gourmet vegetarian component.

The fourth component is an interesting contrast to the insects component as it consists of the pizza with processed insects protein. This component loaded to a lesser degree also on some other easy-to-prepare meals, such as the pasta with pesto, the minced Tivall, and the fried and chocolate-coated locusts. This component seems to be utility driven and will be called the convenience component.

To clarify the factors that influenced the ratings of the substitution options, a set of correlations was calculated. For this purpose, the four components were analyzed in parallel with another form of meat reduction, not covered by the substitution options, namely taking small portions of meat. Table 4 presents the correlations between, on the one hand, the components of the substitution options, complemented by the preference for small meat portions, and, on the other hand, demographic and food choice variables. The latter include meat preferences, familiarity of the substitutes, cooking skills, attitudes towards vegetarian cooking, and food choice motives.

Table 4 demonstrates that there were some specific differences related to gender, age and level of education. The preference for small meat portions was somewhat higher among females ($r = .19$) and persons with a higher age ($r = .11$) or higher education ($r = .15$).

However, the older participants were less in favor of the convenience component with its prominent pizza ($r = -.27$). Except for the ratings of the visible insects, participants with a higher level of education responded somewhat more positively to the soy component ($r = .11$), the convenience component ($r = .14$) and, particularly, the gourmet vegetarian component ($r = .26$).

The meat-related practices were also significantly correlated with several components. The number of meat days was negatively correlated with the soy component ($r = -.19$), the gourmet vegetarian component ($r = -.20$), and the preference for small portions ($r = -.20$). Those who were in favor of the component meal format were more negative about the convenience component ($r = -.23$) and the gourmet vegetarian component ($r = -.27$). In contrast, the preference for small meat portions was slightly positively correlated with the gourmet vegetarian component ($r = .13$), but unrelated to the other components. Apparently, considering portion size is an option that serves as a supplement to the substitution practices.

A measure of the familiarity of the substitution options is the reported frequency of buying instant meat substitutes (8% "regularly", 9% "occasionally" 14% "rarely" 14% "tried once"). Those participants who buy this type of products gave more positive ratings

Table 3

Substitution options: Attractiveness of a plate and the chance of actually preparing a comparable meal at home (text without picture, mean rating^a, SD and loading using rotated Varimax principal component analysis).

Food items (listed in order of mean rating)	M	SD	Component loading			
			1	2	3	4
<i>Omelette^b</i>						
– Attractiveness	2.41	1.40				
– Chance of actually preparing	2.48	1.50				
<i>Pasta with pesto from nuts and herbs</i>						
– Attractiveness	2.97	1.83	.26	-.11	.61	.46
– Chance of actually preparing	3.15	1.92	.28	-.07	.62	.46
<i>Tivall minced-meat, made from soy, here prepared in a tomato sauce</i>						
– Attractiveness	3.21	1.76	.65	-.04	.19	.42
– Chance of actually preparing	3.75	1.95	.71	.02	.16	.32
<i>Moroccan Couscous with chick peas and vegetable</i>						
– Attractiveness	3.86	1.95	.34	.05	.75	.14
– Chance of actually preparing	4.23	2.04	.34	.10	.76	.12
<i>Stir-fry with Seitan. Seitan is an old Japanese wheat product with a spicy taste and texture similar to meat</i>						
– Attractiveness	3.90	1.83	.76	.08	.32	.16
– Chance of actually preparing	4.28	1.91	.76	.13	.33	.13
<i>Tivall steak, instant meat substitute made of vegetables and soy</i>						
– Attractiveness	3.98	1.80	.75	-.01	.14	.20
– Chance of actually preparing	4.45	1.91	.77	.03	.17	.13
<i>Asian stir-fry with tofu and vegetables</i>						
– Attractiveness	4.10	1.88	.76	.09	.32	.03
– Chance of actually preparing	4.49	1.92	.77	.12	.33	-.02
<i>Tofu snack</i>						
– Attractiveness	4.33	1.77	.77	.12	.17	.04
– Chance of actually preparing	4.86	1.80	.78	.15	.17	-.04
<i>Pizza containing protein derived from insects</i>						
– Attractiveness	4.82	1.90	.18	.30	.06	.74
– Chance of actually preparing	5.10	1.87	.19	.37	.08	.72
<i>Indian lentil meal: Daal</i>						
– Attractiveness	4.89	1.88	.26	.09	.80	-.08
– Chance of actually preparing	5.10	1.88	.29	.12	.80	-.09
<i>Fried locust with chocolate coating</i>						
– Attractiveness	5.95	1.67	.08	.64	.01	.43
– Chance of actually preparing	6.38	1.26	.09	.74	.02	.30
<i>Locust salad. Locusts are a delicacy in many African countries; they taste spicy</i>						
– Attractiveness	6.07	1.40	.06	.77	.04	.20
– Chance of actually preparing	6.24	1.36	.02	.73	.06	.11
<i>Salad with fried mealworm</i>						
– Attractiveness	6.60	.93	.09	.84	.05	-.07
– Chance of actually preparing	6.68	.87	.08	.82	.06	-.11
Eigenvalues			6.23	3.82	3.80	2.26

^a Ratings on a 7-points scale (1 = very attractive to 7 = very unattractive; 1 = highly likely to 7 = highly unlikely).

^b The omelette was not included in the principal component analysis.

to the soy component ($r = .42$) and to a lesser extent the gourmet vegetarian component ($r = .27$), but not to the convenience and the visible insects component. Hence, familiarity with instant meat substitutes had no effect on the judgement of options that can be expected to be unknown to all participants.

Skill in the form of knowing how to cook vegetarian was reported by 11% of the participants; this answer was positively correlated with appreciation of the gourmet vegetarian component ($r = .22$). The ratings of the other options were not dependent on this cooking skill. Additionally, those participants who said that they would like to learn cooking vegetarian meals (10% "certainly", 28% "perhaps") gave more positive ratings to the soy component ($r = .38$) and the gourmet vegetarian component ($r = .36$). A closely related measure of vegetarian preferences, a general preference for plant-based snacks and fillings of sandwiches was also associated with positive ratings to the soy component ($r = .24$) and the gourmet vegetarian component ($r = .51$).

The two independent measures of food choice motives, which reveal taste-oriented and reflection oriented motives, had different

correlations with the components. Overall, the appreciation of the substitution options increased when the participants had a more adventurous taste but this was most obvious with regard to the gourmet vegetarian component ($r = .28$) and the visible insects component ($r = .10$). A cross-check revealed that the correlation between taste-oriented motives and the visible insects component was the same for both sexes, although women gave slightly lower ratings to the visible insects ($r = -.09$). The second measure of food choice motives, which differentiates participants who are easy about food from those who are reflective about it, showed that the reflection oriented participants gave more positive ratings to the soy component ($r = .18$) and the gourmet vegetarian component ($r = .14$), but lower ratings to the convenience component ($r = -.14$). The most important characteristic of the reflection oriented participants, however, was a preference for small portions of meat ($r = .30$).

Overall, the correlations presented in Table 4 are not very high. This means that the ordering of the 13 items from most liked to least liked did not completely change among the various categories

Table 4

Correlations between components of substitution options and preference for small meat portions, and demographic and food choice variables.

	Components of meat substitution options				Prefers small meat portions
	Soy-component	Visible insects	Gourmet vegetarian	Convenience component	
Gender (male, female)	.06*	-.09**	.04	.01	.19***
Age	-.02	.01	.04	-.27***	.11***
Education	.11***	.01	.26***	.14***	.15***
Meat days per week	-.19***	.00	-.20***	.01	-.20***
Prefers meal with separate components	-.09**	-.00	-.27***	-.23***	-.01
Prefers small meat portions	.05	-.04	.13***	-.01	
Familiarity: regularly buys substitutes	.42***	.03	.27***	.06	.16***
Skill: able to cook vegetarian	.05	.03	.22***	-.04	.14***
Wants to learn to cook vegetarian	.38***	.04	.36***	.14***	.18***
Preference: chooses plant-based snacks	.24***	.06	.51***	.02	.27***
Taste oriented food choice motives	.07*	.10**	.28***	.06*	-.02
Reflection oriented food choice motives	.18***	.00	.14***	-.14***	.30***

* $p < .05$.** $p < .01$.*** $p < .001$.

of participants. For instance, the participants who preferred the combined meal format gave higher ratings to most of the items than the participants who preferred the component meal format and this difference may partly be explained by the fact that all photos depicted meals that combined ingredients, rather than featuring loose components. However, the ordering of the 13 items among both categories of participants was largely the same (Spearman's Rho = .95, $p < .001$; without including the 5 insect items Rho = .86, $p < .01$). This means that the participants had, to a certain extent, common assumptions about features that make a meal without meat more or less attractive.

Discussion

This study addressed current consumer practices regarding meat consumption and meat substitution in order to clarify attitudes towards various substitution options and identify pathways towards the (partial) substitution of meat in the future. Finding matches between meat-free options, on the one hand, and the practices and motives of consumers, on the other hand, is an important step to identify pathways for a transition. The key idea is that to create an effective dietary change, new practices must be to some degree congruent with the rest of the behavior of the consumer (Ryan & Deci, 2000), which may include the cultivation of an adventurous taste (versus the preference for an ordinary meal) or reflective attention to the implications of food choices (versus being easy about food). The strength of this strategy is also that the primary focus of change efforts is not meat's special status, but its routinized consumption in terms of meat eating days and portion size. However, meat's special status should not be neglected, in particular as it appeared to be closely connected to the structural aspects of meals, and the frames of reference and skills of consumers.

Inspired by this structural thought on food consumption patterns (Douglas, 1972), special attention was paid to consumers' preferences for particular meal formats in which meat is treated as a dominant part of the dish or more as an ingredient. The results showed that the participants had fairly consistent preferences regarding meal formats, which shaped their daily choices of particular cuts of meat as well as their appreciation of meat substitutes. The preference for a component meal was more characteristic of the older participants, grown up during and shortly after World War II, who may be more dedicated to the tripartite structure of meals. This preference made meat substitution options less attractive, in particular dishes with a complete vegetarian meal style.

In contrast, the preference for meals that combine ingredients and the practice of a lower number of meat days per week were

associated with a generally higher appreciation of substitution options. This relationship can also be clarified by a structural approach to food consumption patterns. Participants who reported to eat meat less than 5 days per week and deliberately replaced meat demonstrated a replacement gradient that ran from fish, via eggs, cheese to instant meat substitutes, followed by lentils or other pulses, nuts, and finally seitan, tempeh and tofu. Although meat substitution did not simply follow a linear path, this gradient suggests that participants made use of a hierarchy of foods when thinking of meat substitution. In accordance with Douglas' and Nicod's (1974) finding, the hierarchy features a superiority of products of animal origin above plant foods and cereals. The relevance of this hierarchy as a frame of reference is reflected in the consistency with which the participants made a number of choices in favor of either meat-based or plant-based fillings of sandwiches and snacks.

The ratings of the substitution options also revealed a number of structural differences. Meals where meat is deliberately substituted by substances that imitate the role of meat were distinguished from meals that are not necessarily eaten to deliberately substitute meat, such as a more vegetarian meal style, merging Dutch cooking with more exotic or foreign cuisines. Familiarity with meat substitution is important for the appreciation of both options, but the latter requires more skill than the former and also a stronger preference for plant-based proteins and more taste-oriented food choices. For instance, the preparation of lentils (if not purchased in canned form) is rather cumbersome. Lentils mark the transition towards different meal formats and require skills and food knowledge that people may be less familiar with.

Another distinction is that between visible insects and processed insects protein. Both options were expected to be unknown to the participants and the ratings demonstrated a low level of appreciation, also among participants with an adventurous taste. However, invisible insects appeared to trigger less aversion than pictures that may contain reminders of livingness or of particular textures (Martins & Pliner, 2006). The higher score of chocolate-coated locusts compared with the fully visible insects suggests that presenting insects as a delicacy might be interesting for some consumers. Much more relevant is that processed insects protein may be seen as part of convenience products, which makes their presence less salient.

Before we move on to suggest pathways for substitution, we attend to some limitations of the study. In order to present insects in different ways, we chose to include chocolate-coated locusts because of the visibility of the insects, despite the fact that these cannot be considered a full meal. Future work could explore for example insects coated in a batter to suggest a hearty meal. More

generally, the use of photos to measure responses to the substitution options serves to help the imagination of participants but it also entails that the characteristics making an option more or less attractive may not only be related to the way of substitution but also to characteristics of the context. However, that alone does not explain the pattern of correlations with preferred meal formats, product familiarity, skill, and food choice motives. Another limitation is that this type of survey has difficulties in incorporating the impacts of other household members on food choices. As Lea et al. (2006) mentioned, partners may play an important role in effecting dietary changes. However, a survey is not a reliable way to measure the interactions between household members. A further limitation is that this study is based on single country cross-sectional data, i.e. on consumers in the Netherlands. Generalization of the findings to the broader population may be limited by characteristics of the sample, the sampling method and the geographical scope of the study. Despite these limitations, we are confident about the robustness of our main results regarding pathways towards the (partial) substitution of meat in the future.

Pathways towards meat substitution

In considering these pathways, it is crucial to take due account of the structural distinctions mentioned above. They are closely connected with a number of other factors, such as the availability of products, their familiarity, ease of use, and fit with accustomed meal patterns, which all are shaping consumers' food choices (Wansink, 2002). Hence, one of the more difficult pathways is one that challenges existing meal formats and hierarchies. This requires consumers who are able to make active efforts to break away from existing conventions. For instance, lentils, although not foreign to the local food culture, may be slightly out of fashion and products such as seitan and tempeh traditionally belong to Asian and Indonesian cuisine. To what extent consumers are aware of food choices that deviate from the cultural norm appeared to depend on their degree of education and other personal life experiences, such as their taste. Acquaintance with unusual meal styles, new cooking abilities, a propensity to try out unfamiliar foods may all be needed to explore meals without meat. In this way, eating "differently" can become an important part of one's identity (Jamison, 2003). For example, the New Age (van Otterloo, 1999) and the Slow Food (Parkins, 2004) movement illustrate what such food-related identities could comprise and they demonstrate how a change of diet is embedded in different philosophies of life. Change along this path is sensitive to cultural trends that may or may not accommodate a more sustainable diet and due to its ideological character it may require reflective attention to the wider implications of food choices.

A less difficult pathway does not challenge existing meal formats and hierarchies, but makes an incremental change towards more health-conscious vegetarian meals (Sadler, 2004). For instance, fish, eggs and cheese are already consumed on a regular basis and therefore are readily available as an alternative to meat. Although these options are not very promising from a sustainability perspective (de Boer & Aiking, 2011), the shift may be an intermediate step to get them out of routinized meat eating and subsequently enable the shift towards more plant-based options. Also, instant meat substitutes (including tofu) fit well in this pathway, because they are often marketed as a health-conscious choice, they easily substitute a piece of meat without any further adjustments to meal patterns and they may even be similar to meat in appearance (Hoek et al., 2011). They also allow the easy preparation of a vegetarian component alongside with meat in households where some people eat meat and others don't. This pathway agrees with what Hoek et al. (2004) observed in their analysis of differences between the ideological vegetarians and the more pragmatic

users of meat substitutes. It is also a feasible option for older people, who, according to our findings, depend more on the component structure of meals.

Another pathway is to make substitution more compatible with convenience culture. One way to introduce unfamiliar foods is to combine them with existing foods (Wansink, 2002). The relatively positive score of the fictive pizza with processed insect protein, especially with younger people and less reflection oriented eaters, demonstrates the potential advantages of this path. Convenience oriented consumers who focus on the ease of use may not be too bothered by the idea of consuming insects since they disappear as an ingredient in the processed product and the product remains familiar on the surface. This finding suggests that an introduction of insects as a foodstuff via this path is generally more recommendable than offering the pure insect as a food. More generally, the outcome suggests that there is great potential for the substitution of meat in convenience products, where meat as an ingredient is already less visible and the substitute can be appropriately combined with the meal (Elzerman et al., 2011).

A final pathway to accommodate the range of dietary practices regarding use of animal products involves portion size awareness. Our results indicate that considering portion size is an option that serves as a supplement to the substitution practices. Eating small amounts of meat went together with a smaller number of meat days per week. However, those participants who did appreciate the soy component and also ate meat did not necessarily choose to eat small amounts of meat. This difference may partly be a matter of meal formats, as small portions can easily be incorporated in a different type of diet, such as Mediterranean or Asian diet. Eating small portions may also require reflective attention from a person who considers the implications of food choices in terms of health, weight control and ethical issues (de Boer et al., 2009), which contrasts with less controlled patterns of behavior of consumers who are easy about eating. The latter may be better off with an instant substitute. Still, the pathway is especially interesting because portion size is easily manipulated in food service. Institutional commitments to reduce meat intake, for example in company restaurants, can be undertaken along this path.

Despite its cross-sectional design, the study allows some speculations concerning cultural changes of diet. Differences between age groups potentially point to changing cultural patterns. The results showed that preferences with regards to meat as well as meat substitution and meal formats were influenced by the age of participants and may therefore be subject to cultural changes. The preferences of the younger generation indicate that new meal patterns have established in the Netherlands, in particular combined meal formats and associated kinds of meat such as chicken, sausages and ground meat, while the conventional component meal with typically a cutlet, seems to be fading. Meat's special status is less prominent in this pattern and this change may also simplify a substitution of meat. Although there is a growing interest in healthy eating and a varied diet, which includes incorporating more plant-based foods (Sadler, 2004), the data also underline that a high consumption of meat and a low regard for plant-based options are still the dominant cultural pattern.

Further research should address how the various pathways can be supported by policymakers in industry and government in order to promote changes in a sustainable direction. For instance, to facilitate these changes existing hierarchies of food can be addressed. As Nestle (2002) argues, food guide pyramids have an important role in communicating structural distinctions and hierarchies to consumers. On considering the Dutch example, it occurs that various sources of plant protein, like pulses, nuts and whole wheat, are separated from proteins of animal origin and grouped with breads, pasta and other sources of carbohydrates, instead. An adjustment of this categorization can aid consumers

substantially to (partially) substitute meat in the future. Moreover, the preferences of the younger generation indicate that new meal patterns are being developed, in particular combined meal formats, which may reduce the special status of meat and make substitution easier.

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