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## Consumer acceptance and appropriateness of meat substitutes in a meal context

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### ABSTRACT

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

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### 1. Introduction

Meat plays an important role in the consumption pattern of most European and North-American consumers (FAO, 2004). This can be explained by several factors: (1) meat is perceived as nutritious and healthy (Verbeke et al., 2010), (2) the sensory properties (flavor and texture) of meat are well liked by many consumers (Bredahl, Grunert, & Fertin, 1998; Grunert, 1997; Verbeke et al., 2010), and (3) the consumption of meat is embedded in the culture of Western countries (de Boer, 2006). Although in some countries, like the Netherlands, meat consumption has stabilized over the last decades, global meat consumption and production has dramatically increased over the years (FAO, 2004). Two important driving forces are the growth of the world population and an increase in meat consumption per capita related to the increase of income in developing countries. Meat production, however, is responsible for environmental pressure such as pollution and unsustainable use of resources, due to the inefficient conversion of plant protein to meat proteins (Pimentel & Pimentel, 2003). With the still growing world population in mind, it is important to explore possibilities for a more environmentally sustainable food production chain.

The replacement of meat by plant-based meat substitutes could be an interesting option; however, this is only a realistic option when consumers accept these new products. One prerequisite for the acceptance of meat substitutes is that consumers can recognize a meat substitute as being a product that should be eaten *instead* of meat. This means that the form and usage of meat substitutes should not be too different from meat (e.g. a shake or a soup would not be recognized as a meat substitute by today's consumers). In focus group discussions that preceded this study, many consumers indicated that they found it important that the appearance of a meat substitute was similar to meat products and that it should be clear how to prepare a meal with meat substitutes (Elzerman, 2006). Other important aspects that are required for the acceptance of meat substitutes are the sensory properties of the products (appearance, taste and texture). The taste and texture of meat are highly valued by many consumers (Bredahl et al., 1998; Grunert, 1997). Especially the juiciness and tenderness are well liked texture attributes. Meat substitutes do not have to possess the same sensory attributes in order to be liked by consumers, but taste and texture are important characteristics for the acceptance of a product by meat eaters (Hoek, Luning, Stafleu, & de Graaf, 2004).

To mimic large chops of meat (such as steaks) with plant proteins does not seem to be feasible, therefore, the introduction of 'meat substitute ingredients', smaller meat substitutes that will be served as part of a dish (e.g. in a soup, a sauce, or as a topping on a pizza), seems to be more acceptable (Aiking & de Boer,

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2006; Weaver, Jansen, van Grootveld, van Spiegel, & Vergragt, 2000). Since these ‘meat substitute ingredients’ are not eaten separately, but always as part of a dish, the meal context seems to be of crucial importance for the acceptance of these meat substitutes. Context can be defined as all the variables in a particular eating occasion (Meiselman, Johnson, Reeve, & Crouch, 2000). When a food is eaten as part of a meal, ‘meal context’ refers to all other foods that are part of that meal.

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

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

The research questions addressed in this paper are:

- (1) Does meal context influence the acceptance of meat substitutes?
- (2) Does appropriateness of a meat substitute in a meal influence the acceptance of meals with meat substitutes?
- (3) Do meat substitutes that differ in flavor and texture also differ in their appropriateness in a meal?

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

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

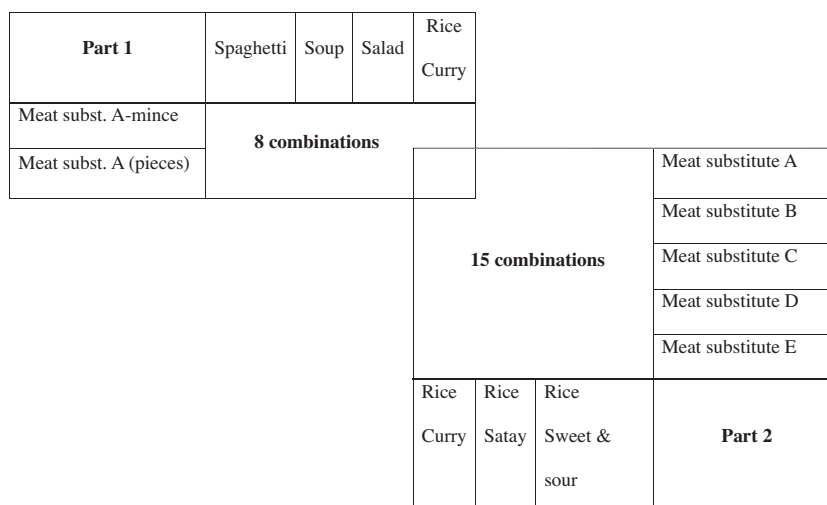
## 2. Materials and methods

### 2.1. Study design

A central location test following a full factorial design was conducted to assess the influence of meal context on consumer responses to meat substitutes. In order to answer the research questions, the test consisted of two parts (see Fig. 1):

#### 2.1.1. Part 1: exploring the role of appropriateness and meal context on acceptance

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



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

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

### 2.1.2. Part 2: influence of flavor/texture on appropriateness and acceptance

The role of flavor and texture on the appropriateness of meat substitutes in meals was assessed by using five meat substitutes in the same form (pieces, but from different brands and made of different raw materials) in three rice dishes. The meal concept of the three rice dishes was the same (i.e. white rice with a sauce containing meat substitutes), so we expected consumers to rate these combinations similarly on appropriateness (*before* tasting the dish). The dishes differed in the ingredients and therefore the flavor and appearance of the sauce. Possibly, one type of meat substitute combines better with a certain sauce than another meat substitute. Therefore, these dishes could be rated quite differently on appropriateness (*after* tasting the dish). Participants evaluated the dishes and rated them on appropriateness *before* and *after* tasting the meal, overall liking, product liking, and intention to use a dish with meat substitutes. Individual meat substitutes were rated on overall liking and 'similarity to meat'. The similarity to meat results will be discussed only in Section 4.

After these two parts of the Central Location Test, we let the participants evaluate the same meals (as described above) with chicken fillet pieces instead of meat substitute pieces. Individual chicken fillet pieces were evaluated as well. This was done to get an idea of the relative heights of the scores of the meat substitutes that were tested in this study. The results of this 'benchmarking' are briefly described in Section 4 of this paper.

## 2.2. Sample preparation, presentation and evaluation

An overview of the samples is shown in Table 1.

### 2.2.1. Part 1: exploring the role of appropriateness and meal context on acceptance

We aimed for meat substitutes that only differed in appearance and form, but were identical in other aspects. Two commercially available meat substitutes with similar ingredients, but different in appearance (color) and form were used: marked as A-pieces and A-mince (the main ingredients are shown in Table 1). The meat substitutes were prepared just before the start of the session using a standardized procedure. The samples of individual meat

substitutes that were served consisted of two table spoons of mince or eight pieces.

The different meal concepts included in this study were:

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

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

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

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

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

### 2.2.2. Part 2: influence of flavor/texture on appropriateness and acceptance

Five commercially available meat substitute pieces were used (product names and main ingredients are shown in Table 1). The samples of the rice dishes that were served consisted of two table spoons of cooked white rice with two table spoons of either curry, satay (peanut sauce) or sweet and sour sauce, combined with eight pieces of meat substitutes. The samples were prepared and kept the same way as the samples in part 1, and the meat substitute pieces were evaluated separately as well as in the three rice dishes.

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

**Table 1**

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

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

**Table 2**  
Questionnaire items that were used for the evaluation of the meal samples.

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

The samples were evaluated before and after tasting, on several outcome measures (Table 2). All questionnaire items were rated on a 100 mm visual analogue scale.

### 2.3. Participants

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

Participants were between 18 and 66 years old (average age was 35, 77% women, 97% had the Dutch nationality, and 54% had a university degree). The habitual meat consumption was less than once a week for 2% of participants, once till twice a week in 12% of participants, three till four times a week for 35% of participants, and more than five times a week for 51% of participants. In general the meat substitute consumption was low, 21% had never eaten meat substitutes and 21% had consumed meat substitutes a few times. Meat substitute consumption of less than once a month was 17%, once a week 19%, once till twice a week 19% and three times till four times a week 4%. In the study meat was defined as meat products that are eaten during the hot meal. Poultry was also defined as meat in this study, while fish and cold cuts were not defined as meat. Meat substitutes were defined as food products that are produced to substitute the function of meat during the hot meal.

### 2.4. Data analysis

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

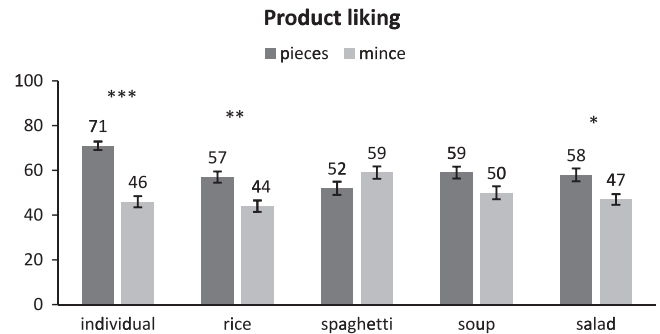
## 3. Results

### 3.1. Influence of meal context on acceptance of meat substitutes

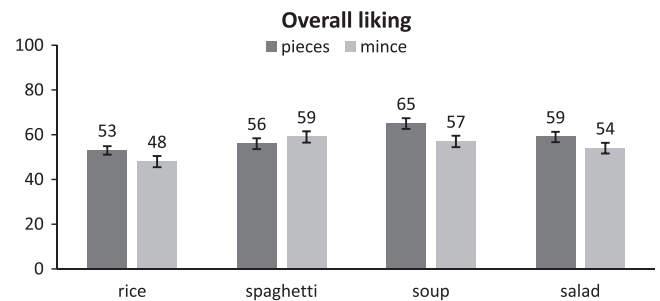
Fig. 2 shows the liking ratings of meat substitutes A-pieces and A-mince when tasted separately and when tasted in a meal context. The individual meat substitutes A-pieces and A-mince differed in overall liking ratings (resp.  $71.0 \pm 1.9$  and  $45.8 \pm 2.5$ ,  $p = 0.000$ ). The product liking ratings (i.e. the liking of the meat substitute in the meal) show that A-pieces were also liked better than A-mince in the rice dish and the salad, but not in the spaghetti and the soup. The differences between the meat substitutes were not found when we compared the overall liking of the dishes (rice, spaghetti, soup and salad) containing these meat substitutes (see Fig. 3).

### 3.2. Influence of appropriateness on meal acceptance

The appropriateness ratings (before tasting) of the eight meat substitute–meal combinations (A-pieces or A-mince in a spaghetti,



**Fig. 2.** Mean product liking ratings ( $\pm$ SEM) of pieces and mince (of meat substitute A), evaluated when tasted individually and in four meals with meat substitutes. Differences between pieces and mince were compared. \*\*\* $p = 0.000$ , \*\* $p = 0.002$ , \* $p = 0.033$ .



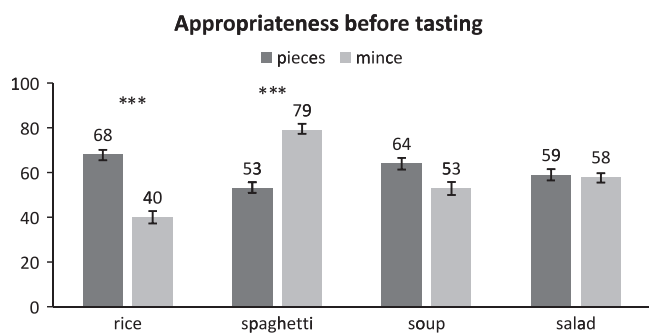
**Fig. 3.** Mean overall liking ratings ( $\pm$ SEM) of four meals with meat substitutes (either pieces or mince of meat substitute A). Differences between pieces and mince were compared.

rice, salad or soup dish) were significantly different ( $F(5.59, 474.87) = 24.51$ ,  $p = 0.000$ ). When we compared the appropriateness ratings (before tasting) of the two meat substitutes (pieces and mince), we found that spaghetti with mince was perceived as the most appropriate combination ( $79.3 \pm 1.7$  as opposed to pieces:  $52.6 \pm 2.7$ ,  $p = 0.000$ ; see Fig. 4). Another appropriate combination was rice with pieces ( $68.2 \pm 2.1$ ), which was more appropriate than rice with mince ( $40.3 \pm 2.8$ ,  $p = 0.000$ ).

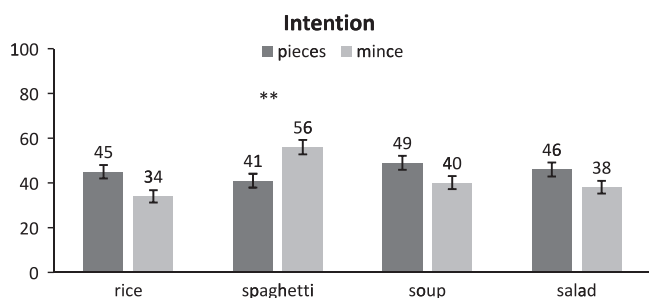
In the soup and the salad, pieces and mince were equally appropriate. The pattern of appropriateness ratings, evaluated after tasting, was similar to the appropriateness ratings before tasting (not reported). The 'intention to use' ratings were lower than the appropriateness and liking ratings, but the same order and significant differences between combinations with pieces or mince were found (Fig. 5).

### 3.3. Influence of flavor/texture on liking and appropriateness

Table 3 shows the significant differences between the mean ratings of the meat substitute pieces for every type of rice dish. There was a significant difference between the mean overall liking ratings of the five individual meat substitute pieces ( $F(4364) = 33.73$ ,  $p = 0.000$ ). A-pieces were liked best ( $71 \pm 1.9$ ), followed by



**Fig. 4.** Mean appropriateness ratings ( $\pm$ SEM) of pieces and mince (of meat substitute A) in four meals with meat substitutes, evaluated before tasting the meal. Differences between pieces and mince were compared. \*\*\* $p = 0.000$ .



**Fig. 5.** Mean ratings ( $\pm$ SEM) of 'intention to use' of four meals with either pieces or mince (of meat substitute A). Differences between pieces and mince were compared. \*\* $p = 0.002$ .

**Table 3**

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

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

<sup>A</sup> Standard error of the mean values were all between 1.9 and 3.3.

<sup>B</sup> 'None' indicates the ratings for the individual meat substitutes (not eaten in a meal context).

E and B ( $60.8 \pm 2.5$  and  $58.2 \pm 2.5$  respectively). C and D scored the lowest on overall liking (resp.  $45.8 \pm 2.8$ , and  $39.0 \pm 2.7$ ).

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

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

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

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

## 4. Discussion

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

### 4.1. Influence of meal context on acceptance of meat substitutes

To answer the first research question, whether meal context influences the acceptance of meat substitutes, we compared the overall liking ratings of the individual meat substitutes with the ratings for 'product liking' (liking of the meat substitutes in the meal). As can be seen in Fig. 2, A-pieces were better liked than A-mince when tasted separately and also when tasted in the rice dish and the meal salad. However, A-mince was rated slightly higher than A-pieces in the spaghetti dish, but this difference was not significant ( $p = 0.55$ ). In the soup, both meat substitutes were equally liked. Although the participants liked A-pieces and mince differently in some dishes, these differences did not seem to matter for the overall liking of the dishes.

Looking at part 2 of the study (Table 3), it can be concluded that the differences in overall liking of the individual meat substitutes to a large extent disappeared in the overall liking ratings of the meals. This is what we expected, because the other ingredients in the meal masked the flavors and texture of the meat substitutes. However, this effect was not the same for all meat substitutes. D, which scored the lowest when tasted separately, was also liked least in the rice dishes (although not all differences were significant). Apparently, the meal context can mask differences in flavor

and texture of (meat substitute) ingredients only to a certain extent. C also scored low separately (and not significantly different from D), but the satay and sweet and sour dishes with C were liked just as good as with meat substitutes A, B, or E. When tasted separately, meat substitute C did not seem to be a strong competitor of A-pieces on overall liking, but the rice dishes with meat substitutes A, B, C or E were equally liked.

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

#### 4.2. Influence of appropriateness on meal acceptance

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

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

The ratings of the soup (meat substitutes served in a fluid dish) and salad (meat substitutes served in a cold dish) were in the same range as the ratings for the rice and spaghetti dishes (Figs. 3 and 4). Thus, in this study, the way the meat substitutes are served (hot or cold, in a sauce, a soup or a salad) did not seem to influence the appropriateness and liking ratings. In contrast with our findings, Puumalainen, Nykopp, and Tuorila (2002) found in their study that when a relatively unknown food (a cereal) was served in two

dishes (as a cooked cereal and in a soup), this did affect the acceptability of the cereal.

#### 4.3. Influence of flavor/texture on liking and appropriateness

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

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

Regarding the appropriateness or match of flavors, we did not find any differences between the meat substitutes in appropriateness *after* tasting the dishes, except for the curry sauce, where the differences between A and B still existed after tasting and D scored also lower than A. As was concluded in Section 4.1, the overall liking scores of the individual meat substitutes and the meals show that the masking effect of the sauces was not the same for all meat substitutes. This suggests that the match of flavors and textures for some meat substitute-meal combinations is better than for others. Seasonings or sauces with familiar flavors have been shown to increase the liking and the willingness-to-taste unfamiliar foods (Pliner & Stallberg-White, 2000; Prescott, Young, Zhang, & Cummings, 2004; Stallberg-White & Pliner, 1999). These familiar sauces may belong to culturally dependent 'flavor principles' (i.e. characteristic flavor profiles that are familiar to the people in a certain group or culture) or to a foreign cuisine that has become familiar to a consumer (Rozin, 2000; Rozin & Tuorila, 1993). In our study, the sauces for the rice dishes were based on Asian cuisines and were well-known to Dutch consumers. We did not find an unambiguous effect of these familiar sauces on the appropriateness (*after* tasting) or product liking of the meat substitutes. Meat substitute A-pieces was liked less in all three rice dishes than when tasted separately, whereas meat substitutes C and D were liked more in the rice dishes than separately.

Different outcome measures have been used in this research. Overall liking is a hedonic or affective measure that is being used in many types of consumer research, whereas appropriateness is more a cognitive judgment (Schutz, 1994) and 'the term

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

The overall liking of the individual meat substitutes ranged from 39.0 (meat substitute D) to 71.1 (meat substitute A), and the product liking of the meat substitutes in the rice dishes from 43.7 (meat substitute D in curry rice) to 64.0 (meat substitute A-pieces in sweet and sour rice). These ratings seem quite low on a 0–100 scale. To get an idea of the acceptance of the meat substitute pieces in this study in comparison to chicken, we served individual chicken pieces and rice dishes with chicken pieces. This was done in a separate and later part of the study using the same participants (data not shown here). When meat substitute pieces were compared to chicken pieces, we found that individual chicken pieces (76.7) scored significantly higher than meat substitutes B, C, D, and E ( $p = 0.000$ ), but not differently from A pieces ( $p = 0.273$ ). However, the product liking of the chicken pieces in the rice dishes was significantly higher than *all* meat substitute pieces in the rice dishes. This underlines the importance of testing foods in the (meal) context they will be consumed in.

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

tion). In line with our findings, 'similarity to meat' did not influence long-term acceptance of meat substitutes either.

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

## 5. Conclusions and implications

We can conclude that in this study:

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

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

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

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