Does extra on pack information impact consumers' understanding of expiry dates and food waste behaviour?

Insights from a real life experiment in The Netherlands

Gertrude G. Zeinstra, Saskia Meijboom, Karen M. de Rosa Spierings, Geertje van Bergen

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Preface

This report is the result of the research that was carried out in the context of the BO-project (BO-43-110-020: "The effect of date marking related visual cues on consumers' decisions to use or discard food in a real-life choice experiment". The research activities within this project were executed independently by Wageningen Food & Biobased Research, and commissioned and financed by the Dutch Ministry of Agriculture, Nature and Food Quality. The aim of this research was to better understand the effects of adding visual cues and extra text about date marking on product packages. Do consumers notice and understand this information? Does it help consumers in distinguishing between best-before and use-by dates? And does it influence consumers in their decision to use or discard foods in a real-life situation, thereby contributing to the prevention of food waste? The WFBR research team was supported by a supervision committee, consisting of four stakeholders in the Netherlands, including the Ministry of Agriculture, Nature and Food Quality, the Ministry of Health, Welfare and Sport, the Netherlands Nutrition Centre and the Foundation Food Waste Free United. The committee is thanked for their involvement and feedback. We thank Hilke Bos-Brouwer, senior scientist at WFBR, for reviewing the report. Special thanks go to Daan Volkers from Praktijkschool Pantarijn for hosting the study in his kitchen classroom. Tycho Slors, Berkay Serçeoğlu and Jurriaan Mes are gratefully acknowledged for their help in preparing the study materials. Finally, we are grateful to the participants that participated in the VICO-study.

On behalf of Wageningen Food & Biobased Research,

Gertrude G. Zeinstra,

Senior scientist and project leader

Summary

This report describes the results of a real-life behavioural experiment conducted in The Netherlands as part of project BO-43-110-020: "The effect of date marking-related visual cues on consumers' decisions to use or discard food in a real-life choice experiment". The aim of this study was to investigate whether extra on-pack information about date-marking affects consumer's understanding of date-marking and their corresponding behaviour in a realistic setting. The research activities within this project were executed independently by Wageningen Food & Biobased Research (WFBR), and were commissioned and financed by the Dutch Ministry of Agriculture, Nature and Food Quality. The WFBR research team was supported by a supervision committee, consisting of four stakeholders in the Netherlands, including the Ministry of Agriculture, Nature and Food Quality, the Ministry of Health, Welfare and Sport, the Netherlands Nutrition Centre and the Foundation Food Waste Free United.

About one third of all food produced globally goes either lost or wasted. In the European Union, the total amount of food wasted in 2020 approximated 59 million tons. Food loss and waste does not only lead to economic losses, but also leads to societal and environmental losses. Therefore, the United Nations have set the Sustainable Development Goal (SDG) 12.3 in 2015, which aims to halve global food loss and waste by 2030. Both the EU and The Netherlands have committed themselves to this target. The aims of this research project align with the developments within the European policy domain. The issue of date marking is an important focus area in the European Farm to Fork Strategy (2020) and a priority topic of the multi-stakeholder EU platform on Food Loss and Food Waste. During the project's run-time, the Commission worked on the revision of an amendment to the EU regulations on date-marking. The Dutch government works together with several partners via the Green Deal collaboration and the Foundation Food Waste Free United to reduce food waste among consumers via a better understanding and improved use of the two expiry dates.

Dutch households are responsible for 25-35% of the food loss and waste in The Netherlands, wasting 33.4 kg of food per person per year (Voedingscentrum, 2023). Consumers' food waste behaviour is influenced by various factors. One of the factors contributing to avoidable food waste at home, is confusion about how to interpret and use the two date marking types (use-by and best-before) that are obligated under current EC legislation (n. 1169/2011). Less than half of European consumers understand the meaning of the best-before and use-by date. To date, few studies have experimentally investigated whether providing additional information helps consumers in their understanding of expiry dates, and its effect on food waste behaviour at home. In a recent online choice experiment (Zeinstra et al., 2021), we showed small positive effects of additional on-pack date-marking information (explanatory text with or without a visual symbol) on consumers' behavioural intentions (i.e. hypothetical choices to look-smell-taste, eat or discard expired foods). The aim of the current study was to investigate whether these findings extend beyond hypothetical choice situations. To this end, an experimental consumer study was executed in a realistic food management context.

Participants were recruited under the guise of the study aim "to get insight into social influences on food choices". The real aim was not disclosed beforehand to minimize behavioural bias regarding expiry dates during the experiment. Forty-two participants (mean age 32.1 ± 9.7 years; 76% female) came to the study location, a kitchen classroom in a secondary school. They received 12 food products (six use-by, six best-before) with fictive expiry dates (eight expired, four non-expired). They were instructed to prepare a snack platter with as many products as possible, as long as the products were still good to eat. They were told that part of the products were left over from a festive party at school to subtlety hint towards the idea that some products could be expired. Product expiry dates were manipulated by means of stickers, which occurred in two experimental conditions (between-subjects). They either included extra date-marking information (visual icon and additional text; cue condition) or not (no-cue condition). For best-before dates, an arrow showing the three senses (eye, nose and mouth) and the text "Often good after date; look, smell, taste" was used. For use-by, a stop-hand was used with the text "Use before or on the date; do not used after date".

In order to make the experimental manipulation as realistic and discrete as possible, all stickers were designed to match the original product packaging in font and size. During the task, participants' smelling and tasting behaviour was observed, and choices to use or discard products were registered. Upon completion of the snack platter, participants filled out a questionnaire to investigate a) whether the cues were noticed; b) respondents' understanding of use-by and best-before dates, and c) their perceptions about the extra information. Subsequently, they engaged in a group discussion where the snack platters were served and consumed.

Results partially confirmed the findings from the online experiment. As hypothesized, products exceeding the use-by date were discarded more often in the presence of additional on-pack information, which can be seen as desirable behaviour from a food safety perspective. For products beyond the best-before date, however, no evidence was found that extra on-pack information led to the hypothesized reduction in discard choices, as products exceeding the best-before date were hardly discarded. This finding might relate to the characteristics of our sample (who expressed relatively high confidence in assessing the safety of expired foods and consciousness about the food they waste) or to the relatively short expiration periods. Nevertheless, observational insights suggested that on-pack cues did encourage tasting of some (but not all) products past the best-before date, while discouraging tasting of some (though not all) products past the use-by date.

Despite the behavioural cue effects observed in the experiment, findings from the questionnaire and the focus groups provided no evidence for a difference between the cue and no-cue group in understanding of date-marking terminology. The majority of participants (87%) indicated to know the difference between best-before and use-by dates, but half of their definitions were not specific enough to determine whether their understanding was indeed correct. Findings from a product sorting task (place products in a use-by or best-before box) showed that all but two participants distinguished between the most perishable (raw meat) and least perishable product (sugar), yet a quarter of participants reversed the corresponding terms (i.e. placed raw meat in the best-before and sugar in the use-by box). For less typical products (e.g. dairy), categorizations were less uniform. Together, these results suggest that participants typically rely on product-related knowledge rather than date-marking terms when evaluating the safety of foods. Despite their self-reported understanding of date-marking terms, the majority agreed that extra information would be helpful in deciding what to do with expired foods, which suggests that current date-marking terms are not (clear enough to be) used for this purpose. This was confirmed in the focus group discussions, where multiple participants indicated not to pay attention to the words preceding the date (and hence not to differentiate between use-by and best-before) when checking expiry dates. Moreover, only 26% of participants recalled having seen one or both visual symbols on the product packages when preparing the snack platter. Our sample personally valued extra textual information more than visual symbols, because the text was more clear and directive. Participants suggested and to make the symbols more prominent, and to use a combination of text and visuals to reach the largest possible audience.

With this study, we have obtained valuable insights in consumer date-marking understanding and related food waste behaviours, which can feed the debate about date-marking activities and policies. This is the first study to show that extra on-pack date-marking information can positively alter consumer food management practices in a realistic setting. Although behavioural effects were restricted to expired use-by foods, findings highlight the potential of on-pack communication in helping consumers to distinguish between use-by and best-before dates. Moreover, given that behavioral effects occurred irrespective of consumers' understanding of date-marking terminology, findings imply that educational date-marking activities should explicitly target the associated actions (i.e. what to do with expired foods) to effectively impact food waste behaviours.

1 Introduction

This reports describes the results of a consumer study that was conducted in The Netherlands as part of the project BO-43-110-020: The effect of date marking-related visual cues on consumers' decisions to use or discard food in a real-life choice experiment. This project further extends on the research that has been executed in a previous project (BO-43-002-02) which explored whether date-marking related visual cues on food packages can contribute to reducing food waste in Dutch households via an online experiment within a survey study. The aim of the current project was to investigate the effects of adding additional information to product packages (a visual cue plus explanatory text) on consumers' understanding of expiry dates and their discarding behaviour (food waste) in a more realistic setting.

The research activities within this project were executed independently by Wageningen Food & Biobased Research, and commissioned and financed by the Dutch Ministry of Agriculture, Nature and Food Quality. The research team of Wageningen Food & Biobased Research (=WFBR) was responsible for the design, execution, data analysis and reporting of the research activities within this project. Four stakeholders in The Netherlands were involved in a supervision committee that advised and supported the WFBR project team: the Ministry of Agriculture, Nature and Food Quality; the Ministry of Health, Welfare and Sport, the Netherlands Nutrition Centre, and the Foundation Food Waste Free United.

This research and its results need to be understood against the backdrop of the developments at EU level. Date-marking related food waste is a priority topic of the EU Platform on Food Loss and Food Waste. This platform is a mandated multi-stakeholder platform that brings together national governments, business and societal actors, as well as academia. It aims to support all actors in achieving the EU targets of halving food loss and waste by 2030 (as laid down in the Farm to Fork Strategy) and the UN Sustainable Development Goal 12.3. During the project's run-time, the Commission worked on the revision of EU regulations on date-marking, which was called for by the new Farm to Fork Strategy. In doing so, the Commission aims to prevent food waste linked to misunderstanding and/or misuse of these dates, whilst ensuring that any proposed change meets consumers' information needs without jeopardising food safety. The Commission has carried out an impact assessment (with public and targeted consultations) as well as consumer research to support its proposal (Open Evidence, 2021). In the beginning of 2023, the European Commission has proposed an amendment of EU regulation No 1169/2011 Annex X, which applies to best-before dates specifically. In the proposed amendment, the currently required words preceding the expiry date ('best before…') will be extended to include the words 'often good after' (Dutch translation: 'vaak goed na') following the date. The findings of this research project will contribute to and feed these developments at the EU and national level.

1.1 Background

About one third of all food produced globally goes either lost or wasted (Gustavsson et al., 2011). In the European Union, the total amount of food wasted in 2020 was almost 59 million tons, of which 53% was generated in households (Eurostat, 2023). It is estimated that Dutch households are responsible for 25-35% of the food loss and waste in The Netherlands (Soethoudt & Vollebregt, 2020). Looking at absolute numbers, Dutch households waste 33.4 kg of food per person per year (Voedingscentrum, 2023). The top five of food groups contributing to Dutch consumers' food waste are: bread and bread-based products (6.2 kg); vegetables (4.4 kg); fruit (4.3 kg); potatoes (2.8 kg) and dairy (2.8 kg). Whereas consumer food waste in The Netherlands has been reduced with 23% since 2015, the amount of food waste seems to stabilize between 2019 (34.3 kg) and 2022 (33.4 kg).

Because food loss and waste leads to economic, societal and environmental losses (Chen et al., 2020; FAO, 2013; United Nations Environment Programme, 2021), Sustainable Development Goal (SDG) 12.3 has been set in 2015 by the United Nations. SDG 12.3 aims to halve global food loss and waste by 2030. Both the EU and The Netherlands have committed themselves to this target, and it is included in the EU Farm to Fork Strategy (2020) and also the main aim of the Foundation Food Waste Free United. This foundation is a Dutch movement in which all important initiatives and expertise for a waste-free Netherlands come together to

accelerate food waste-related changes. Companies from the entire food supply chain, knowledge institutes, governments and social organizations work together on the joint ambition of SDG 12.3 by retaining 1 billion kilos of food within the food supply chain every year.

In order to reduce food waste and develop effective interventions, it is important to know which factors influence the food waste behaviours of consumers. Figure 1 shows that consumers' food waste behaviour is influenced by various factors (Van Geffen et al., 2016; Vittuari et al., 2023). Consumers' motivations, their abilities and the opportunities to engage in food waste prevention predict the amount of consumer food waste generated. This model is valuable since it acknowledges that food waste is the result of multiple food management sub-behaviours, as well as that many of these behaviours occur unconsciously (Quested et al., 2013; Russell et al., 2017; Van Geffen et al., 2016). In general, consumers do not intentionally waste food (Van Geffen et al., 2016).

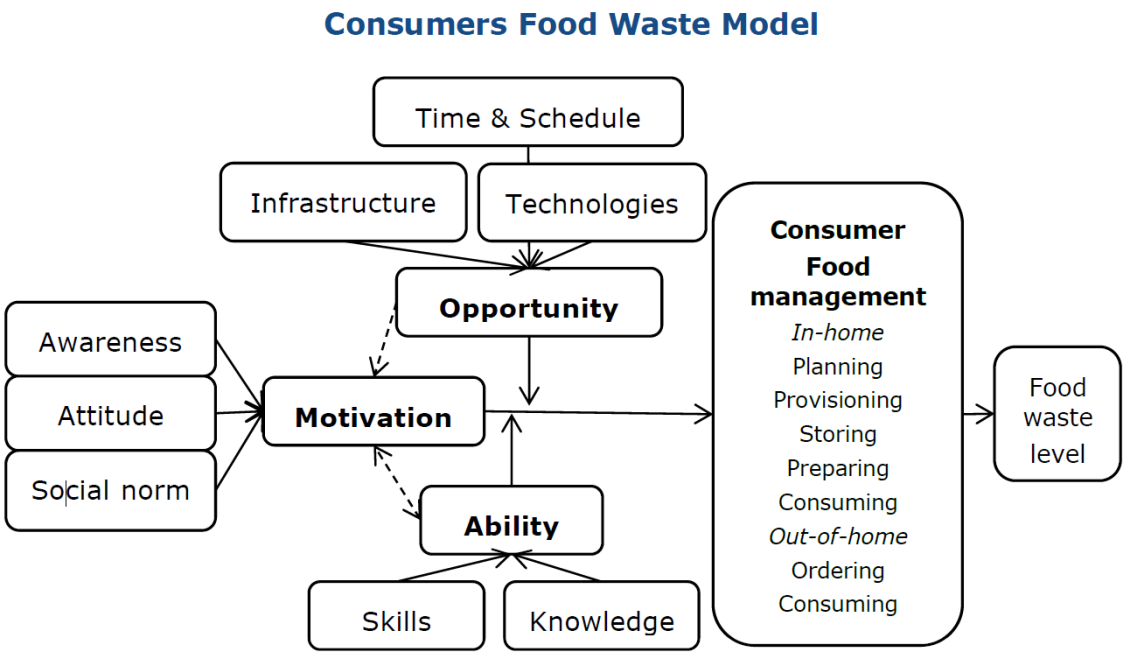

Figure 1 Consumer food waste model (Van Geffen et al., 2016).

Date marking has been identified as an important contributor to food waste, accounting for approximately 10% of household food waste (European Commission, 2018). In particular, uncertainty or confusion about the two date marking types (use-by and best-before) that are obligated under current EU legislation (No 1169/2011), could contribute to unnecessary food waste at home. Many consumers do not know the difference between use-by (TGT) and best-before (THT) expiry dates (Aschemann-Witzel et al., 2015; Parfitt et al., 2010; Principato et al., 2015) and this problem seems to be present worldwide (Patra et al., 2022; Turvey et al., 2021). Previous research indicates that only 47% of European consumers have a good understanding of the meaning of best-before labels, whereas 40% understands the meaning of use-by labels (European Commission, 2015). Research in The Netherlands shows that the number of Dutch consumers that state to know the difference between the two expiry dates has increased between 2019 (59%) and 2022 (68%). However, when prompted, not all consumers within this group can actually define the two dates correctly. As a result, both in 2019 and 2022, 46-47% of Dutch consumers do really know the difference between use-by and best-before dates, whereas 53-54% does not (Voedingscentrum, 2019, 2023). In addition, approximately 10% of Dutch consumers discard foods which have passed the best-before date (Voedingscentrum/GfK, 2017). Three quarters of the Dutch population stated in 2022 to look, smell and taste best-before products when the expiry date has passed, which is somewhat higher than the 69% in 2019 (Voedingscentrum, 2019, 2023). Providing information about the difference between use-by and best-before dates and guidance on how to handle expired products is expected to improve consumers' abilities, leading to better food management (i.e., not discarding expired best-before products) and thereby result in less food waste.

The topic of food waste has received increasing interest from the scientific community: since 2016, the number of scientific publications has risen (Simões et al., 2022; Vittuari et al., 2023). The majority of these articles focus on understanding food waste behaviour, whereas there are much fewer studies investigating interventions to reduce food waste (Simões et al., 2022; Zeinstra et al., 2020). It is also challenging to assess the effectiveness of these interventions (Simões et al., 2022; Vittuari et al., 2023) and empirical studies about real-life food waste behaviour are complex (D'Amato et al., 2023). Some recent reviews state that the majority of studies use self-report measures of food waste to assess the effectiveness of interventions, which is known to be prone to bias (Simões et al., 2022; Vittuari et al., 2023). The inventory of Simões et al. (2022) resulted in 18 food waste reduction interventions focusing on various drivers or barriers. Only one of these interventions focused on supporting a better knowledge and understanding of date markings. This study showed that clarifying the meaning of date markings was insufficient to change consumers' preferences (i.e. willingness-to-pay) for food past its best-before date. However, when consumers received information on food dating as well as information about the link between date labels, food waste, and its environmental impacts, participants' willingness-to-pay for expired food increased. This was particularly the case for expired frozen or recently expired semi-perishable products (Collart & Interis, 2018). Another study in the US (not mentioned in the review of Simões et al.) showed that an educational approach via providing additional information messages resulted in a significant increase in general understanding of 'Best If Used By' (from 64.0% to 82.0%) and of 'Use By' (from 44.8% to 82.4%), with no difference between the seven different messages that were tested in this study (Turvey et al., 2021). However, no food waste behaviour measures were included in this study.

A recent study in The Netherlands (Zeinstra et al., 2021) focused on exploring the potential of on-pack information about date-marking in reducing consumer household food waste. The additional information on the product package was presented in the form of extra text with or without a visual cue. It was hypothesized that the additional on-pack information would improve consumers understanding of these date labels and thereby lead to the desired food waste related behaviours (look-smell-taste, eat or discard), ultimately leading to less food waste. This online choice experiment showed small positive effects of additional date-marking information on consumers' behavioural intentions. The additional information affected respondents' choice behaviour (eat vs. discard vs. look-smell-taste) in the desired direction. For best-before products, respondents were less likely to discard these overall. Furthermore, they were more likely to eat best-before products on the expiry date and to look-smell-taste the products past the expiry date. For use-by products, respondents were more likely to eat these on their expiry date and to discard them past their expiry date. Despite these promising results, the question arises to what extent these findings translate to more realistic choice situations. Are consumers equally sensitive to the date-marking cues if these are presented in realistic format on product packages? What if consumers have the products in their hands and can use their senses to evaluate the safety and quality of foods? And what if consumers are faced with the actual consequences of their choices?

These questions formed the starting point for this project, in which a consumer study was executed to further study the effectiveness of extra date-marking information on consumers' understanding of date labels and their food waste related behaviours. The consumers in this study were placed in a realistic - yet experimentally controlled - food preparation context. We focused on their behaviour during this task in order to deepen our understanding of the processes underlying consumers' decisions to use or discard foods.

1.2 Objectives

The objective of this pilot study was two-fold. First, we aimed to replicate our previous findings and provide further evidence that extra on-pack information about expiry dates can help consumers to distinguish between use-by and best-before dates. Second, we aimed to increase the external validity of our previous findings by investigating to what extent effects of on-pack information extend to more realistic food management situations. Several research questions were defined for this project:

- Do consumers notice the extra information about expiry dates on the product packages?
- Does the extra information lead to a better understanding of (the difference between) use-by and best-before dates?
- Does the additional information impact the choice behaviour of consumers?
    a. Does it encourage consumers to use products past the best-before date (resulting in less food waste)?

b. Does it discourage consumers to use products past the use-by date (desired from a food safety perspective) and/or encourage consumers to use products *on* the use-by date (resulting in less food waste)?
c. Does the extra information influence the extent to which consumers rely on their senses to evaluate product quality and safety?

Since the additional information (cues) focuses on what to do with expired foods, it was hypothesized that cue effects would be limited to products past the expiry date. Moreover, cue effects on product discard behaviours were expected to go in opposite directions for use-by versus best-before dates.

2 Method

2.1 Participants

Participants were recruited from the Food Research participant panel of Wageningen University and Research. Inclusion criteria were: age 18-50 years; not being vegetarian or vegan; no allergies for any of the products used in the study; not being a former pupil of, or having a child at, the Pantarijn Praktijkschool (the research location). During recruitment, participants were told that the aim of the study was to get insight into social influences on food choices and that the study consisted of three activities. The real purpose of the research was not disclosed prior to participation to minimize bias, i.e. a) the likelihood of sample bias (we did not want to include only consumers who are very conscious about food waste), and (b) to minimize the likelihood that participants would adapt their regular (food discard) behaviour based on their knowledge of the true research purpose.

From the eligible participants (N=77), 54 were selected and assigned to one of two experimental groups (27 Cue, 27 No-Cue) which were balanced on age, gender and household composition. Participants were scheduled for one of six experimental sessions on three test days (one Cue session and one No-Cue session per day; nine participants per session). Fourteen participants did not attend their scheduled session (four no-shows and ten last-minute cancellations), two of whom could be replaced with participants on the reserve list. This yielded a final sample of 42 participants for analysis (19 Cue, 23 No-Cue). Sample characteristics are provided in Table 1. The sample was on average 32 years old, 76% was female and the majority had a higher education level (71%) and no children (71%). Households consisting of one (36%) or four members (26%) were most common in our sample.

Informed consent was obtained from all participants upon arrival at the test location (prior to the start of the session). Participants were initially presented with a cover story (see Procedure section), but debriefed about the real study aim towards the end of the session; none of the participants objected to this procedure. At the end of the session, all participants received a gift voucher of 20 euros to thank them for their participation. The study was reviewed and approved by the Social Sciences Ethics Committee of Wageningen University (Annex 1).

Table 1 Sample characteristics in frequencies N (%) or mean ± SD.

		Full sample	**Cue group**	**No-Cue group**
		N=42	**N=19**	**N=23**
Gender	N (%) female	32 (76%)	15 (79%)	17 (74%)
Age	*Mean ± SD*	32.1 ± 9.7	30.9 ± 9.9	33.1 ± 9.7
	range	20-48	20-48	20-48
Education level	*low*	2 (5%)	1 (5%)	1 (4%)
	middle	10 (24%)	5 (26%)	5 (22%)
	high	30 (71%)	13 (69%)	17 (74%)
N household	*1*	15 (36%)	6 (32%)	9 (39%)
members	*2*	5 (12%)	3 (16%)	2 (9%)
	3	3 (7%)	1 (5%)	2 (9%)
	4	11 (26%)	8 (42%)	3 (13%)
	5 or more	9 (21%)	2 (11%)	7 (30%)
N children (<18 years)	*0*	30 (71%)	14 (74%)	15 (65%)
	1	2 (5%)	0 (0%)	2 (9%)
	2	6 (14%)	4 (21%)	2 (9%)
	3 or more	4 (10%)	0 (0%)	4 (17%)

2.2 Design and procedure

2.2.1 Study design

The experimental sessions consisted of three activities. The first was a food preparation task, during which participants prepared a snack platter, to be eaten together with the other participants later on. Products to be used for this task were given experimentally manipulated expiry dates which followed a between-subjects design. In half of the sessions, each product package included a visual cue and a textual explanation about the expiry date (Cue sessions); in the other half, product packages did not contain any additional information (No-Cue sessions). After completing this task, respondents completed individually a short questionnaire to capture their current perceptions and knowledge, as well as their experiences of the food preparation task. Subsequently, they participated in a focus group discussion where they were debriefed on the real study aim and where their experiences with the food preparation task were further discussed, as well as their habitual practices regarding date marking.

2.2.2 Products and expiration dates

Twelve products (six use-by, six best-before) were included in the experiment. The products were selected to present a varied range of products that would fit well on a snack platter. Original date-marking information on the product packages was covered with a fictive date-marking sticker creating the suggestion that the products were either close to, on or past their expiry date (Table 2). In reality, none of the products were expired to ensure food safety; the stickers covered the actual product expiry dates. An important product selection criterion was that the product packages allowed for covering the original dates without being too obvious (in terms of colour differences or amount of space needed).

Table 2 Products and expiration dates used for the food preparation task.

Product	**Date type**	**Expiration date**			**Interpretation**
		Test day 1 (25.01.2023)	*Test day 2 (26.01.2023)*	*Test day 3 (31.01.2023)*	
Smoked salmon	Use-by	25.01.2023	26.01.2023	31.01.2023	not expired
Snack carrots	Use-by	25.01.2023	26.01.2023	31.01.2023	not expired
Sweet peppers w. cream cheese	Use-by	24.01.2023	25.01.2023	30.01.2023	1 day expired
Chicken skewers	Use-by	24.01.2023	25.01.2023	30.01.2023	1 day expired
Freshly sliced mango	Use-by	23.01.2023	24.01.2023	29.01.2023	2 days expired
Fresh tzatziki	Use-by	23.01.2023	24.01.2023	29.01.2023	2 days expired
Olives	Best-before	03.02.2023	03.02.2023	03.02.2023	not expired
Almonds	Best-before	end 02.2023	end 02.2023	end 02.2023	not expired
Hummus	Best-before	22.01.2023	23.01.2023	28.01.2023	3 days expired
Brie	Best-before	22.01.2023	23.01.2023	28.01.2023	3 days expired
Dry-cured pork sausage	Best-before	18.01.2023	19.01.2023	24.01.2023	1 week expired
Toasted bread sticks	Best-before	22.12.2022	22.12.2022	22.12.2022	±1 month expired

In order to make the date-marking manipulation as realistic and discrete as possible, date-marking stickers were designed to match in size and in font with the original package labels. An example of a use-by and a best-before date marking sticker in both conditions is provided in Figure 2.

Figure 2 Examples of use-by (top) and best-before (bottom) date-marking stickers in the Cue (left) and No-Cue (right) condition.

All products were bought at one supermarket (PLUS). Highly perishable products were delivered the day before each test session; less perishable products were delivered in the week prior to the start of the study. Date-marking stickers were placed on the packages by the research team and the products were stored according to the requirements on the package (i.e. either at room temperature or in a refrigerator at 4-7º Celsius).

2.2.3 Procedure

The experiment was executed in January 2023 at Pantarijn Praktijkschool (secondary school for practical education) in Wageningen. Upon arrival, participants were welcomed by the researcher team and provided written consent. Subsequently, one researcher (the same person for all test sessions) explained the purpose of the research and the study procedures. The real purpose was not disclosed beforehand to minimize biased behaviour during the experiment. Instead, a fictive goal was presented in a cover story, which included plausible reasons for (a) the alternative research location and (b) food products potentially exceeding their expiry dates, without explicitly focusing on date-marking and food waste:

> *"Welcome at Pantarijn school for practical education. For those who are unfamiliar with this: practical education is intended for students that need extra support, where 'learning by doing' is key. Students in the school follow their own learning path and work at their own level, by which they are trained and prepared for a place on the labor market.*
>
> *Last week, the school had a festive week, during which all kinds of activities were devised and organized by the students themselves. The week ended with a get-together for all the students, their parents and the teachers of the school. The students of the fourth grade organized the catering for this event, under the supervision of their cooking lessons teacher.*
>
> *We will now go to the kitchen classroom, where each of you will be assigned a kitchen unit. There you will find various leftover products from the get-together. Some of the products come from the pantry, which the students first consulted when making their shopping list. Other products were purchased from the local supermarket. We ask you to put together a snack platter with these leftover products. Make the platter as varied as you can: use as many products as possible, as long as they are still good to eat. Feel free to taste if you wish. You can make use of all the trays, dishes, cutlery, etc. that are available at your kitchen unit. When you are ready, we will take photos of your snack platters, which will be compared with the presentation of the snack platters by the students."*

In the kitchen classroom, participants were further instructed 1) to wash their hands first; 2) to place all products they did not use for the snack platter in a discard basket; 3) to do the task by themselves without talking to their neighbour participants and; 4) that they did not have to clean the kitchen unit when ready. During the snack platter preparation task – which took 20 minutes on average – four researchers observed participants' behaviour (2 participants per observer). Via an observation form, they registered which products participants smelled and/or tasted when preparing the platter. When participants were finished, a photo was taken of the snack platter, and the research team wrote down on the form for each product whether it was used or discarded, and (for discarded products) whether or not the package was opened before discarding. Participants were brought to an adjacent room, where they filled out an online questionnaire assessing (a) whether they had noticed the visual date-marking cues as well as other information on the product packages; (b) their understanding of the visual date-marking cues; (c) their understanding of use-by and best-before dates; (d) their attitudes regarding food waste. The full questionnaire (together with the results per question) is provided in Annex 3. Upon completion of the questionnaire (~ 15 minutes), participants were divided into two small groups (three to four participants) to engage in an informal group discussion. During the discussion, experiences of the snack platter preparation task were shared and the real purpose of the study was disclosed. Subsequently, the perceived effectiveness of additional date-marking cues was discussed as well as participants' habitual behaviour in relation to date marking information. Discussions followed a semi-structured discussion guide, which is provided in Annex 2. Discussions were led by one of the researchers while a second researcher took notes. The group discussions took 30 to 40 minutes and were sound recorded to complement the notes. In each group, two snack platters were served to start the discussion; participants were told they could eat anything they wanted from the platters. At the end of the session, participants were invited to take home as much of the products used on the snack platters as they wished in a 'doggy bag'. A full session with the three activities took 90 minutes on average. At the end of each test day, products that were not used on the snack platters were offered to the teachers and students of the school.

2.2.4 Data analyses

Food preparation task

Effects of the additional date-marking information on product choices (use vs. discard) during the food preparation task were assessed by means of mixed-effects logistic regression analyses. Models predicted the probability of using (vs discarding) products on the basis of Date (on or before vs past the expiry date), Product Type (use-by vs. best-before), Group (cue vs no-cue) and their interactions. To account for participant- and product-specific idiosyncrasies, models additionally included random intercepts for participants and products. Similar analyses were performed for smelling (smelled vs. not smelled) and tasting (tasted vs. not tasted) behaviour. Model estimates (β), confidence intervals (SE) and p-values are reported; p-values <0.05 were considered significant. Significant interactions with Group were followed up with separate analyses per group. For visualizations, product choices (% used) and smelling/tasting behaviour (% smelled, % tasted) were summarized per product type, expiry date (before/on vs. past) and per group (cue vs. no-cue). To explore inter-individual variation between products and participants, product choices and smelling/tasting behaviour (% used, smelled, tasted) were summarized per product and per participant.

Questionnaire

Responses were summarised for the full sample and per group (cue versus no cue). For Likert-scale ratings, means, SDs and % (dis)agree are reported; for categorical questions, frequencies and percentages are reported. To assess whether additional date-marking information during the food preparation task influenced participants' responses, group comparisons (cue vs. no-cue) were performed using independent samples t-tests (ratings) or contingency tables (categorical responses); p-values <0.05 were considered significant.

Focus group discussions

A qualitative analysis was performed on the group discussion data to identify key themes and to explore differences and similarities between the Cue and No-Cue groups.

3 Results

3.1 Food preparation task

This section describes the key findings regarding use vs. discard choices and smell and taste behaviour during the food preparation task. The full results from the logistic regression analyses are summarized in Annex 3.

3.1.1 Use vs. discard choices

Figure 3 shows the percentage of use-by and best-before products on (before) vs. past the expiry date that participants used on the snack platters (vs. discarded) in the cue and no-cue group. The figure shows that product use overall was higher than product discarding. Generally, about 80% of the products were used and about 20% was not used (discarded). A difference between groups can be seen for use-by products past the expiry date, which were used less often in the cue group relative to the no-cue group (51% vs. 84%, respectively). The logistic mixed-effects regressions analysis revealed a significant Date x Product Type x Cue interaction (p=.018), confirming that the additional cues affected the likelihood to use products differentially across expiry dates and product types. To further interpret this three-way interaction, follow-up analyses were performed per group. For the cue group, a significant Date x Product Type interaction effect was found (p=.009), such that the likelihood to use products past (vs. on) the expiry date decreased for use-by products (p=.001), but not for best-before products (p=.86). For the no-cue group, no significant effects were found (p's≥.54), suggesting an overall high likelihood to use products regardless of product type or expiry date. These results show that additional date-marking information influenced participants' choice behaviour regarding use-by products in the desired direction (in terms of food safety); however, the hypothesized cue effect on choice behaviour regarding best-before products could not be confirmed.

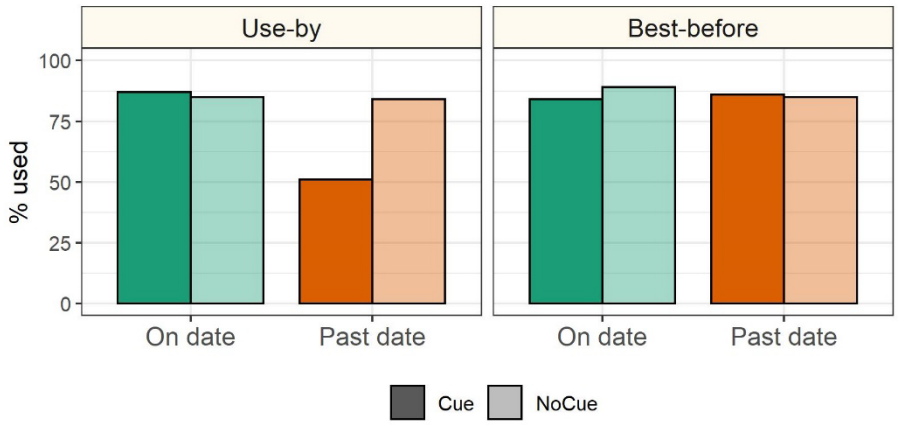

Figure 3 ***Percentages of use-by (left) and best-before (right) products before/on (green bars) vs. past (orange) their expiry date used on the snack platters in the cue (dark shades) and no-cue group (light shades).***

3.1.2 Smell and taste behaviour

Figure 4 shows the relative smell and taste frequencies of use-by and best-before products in the cue and no-cue group during the food preparation task. As can be seen from the figure, products were neither smelled nor tasted in the majority of cases (<35%). The logistic mixed-effects regression analyses of smelling behaviour showed a main effect of Date (p=.007), indicating an increased likelihood to smell products past (23%) versus on (9%) the expiry date. No evidence was found that smelling behaviour differed between product types or groups.

For tasting behaviour, Figure 3 suggests a cue effect for best-before products past the expiry date, which were tasted more often in the cue group relative to the no-cue group (33% vs 18%). However, the analysis of tasting behaviour provided no evidence for any Group effects (p's≥.19). The analysis did show a

significant main effect of Product Type (p=.02) such that best-before products were overall more likely to be tasted than use-by products (21% vs. 10%).

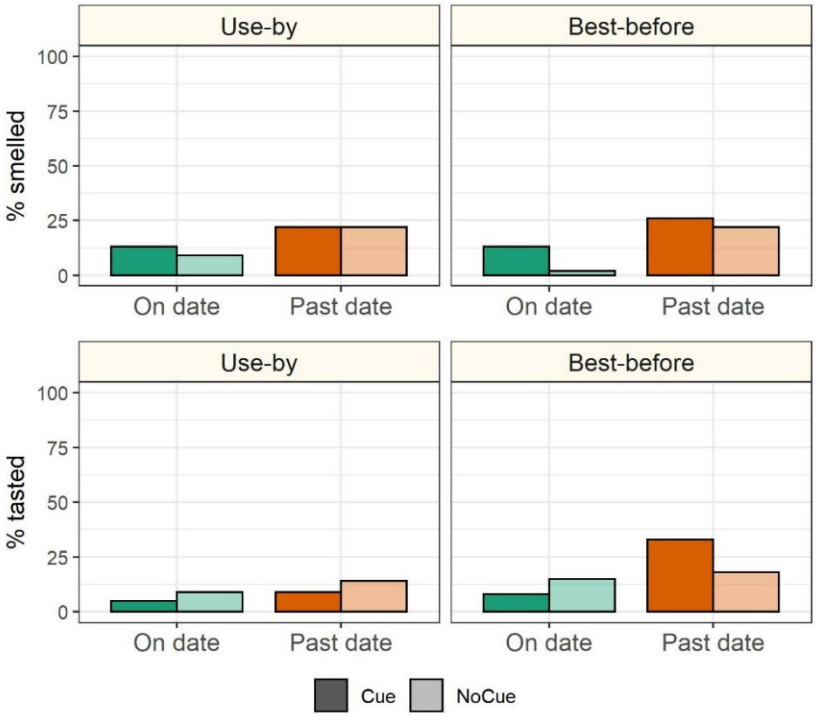

Figure 4 ***Relative frequencies of use-by and best-before products before/on (green bars) vs. past (orange) the expiry date smelled (top) and tasted (bottom) in the cue (dark shades) and no-cue group (light shades).***

3.1.3 Product variation

The main analysis showed that cue effects on choice behaviour were restricted to use-by products past the expiry date (which were used less often if additional date-marking information was present); no evidence was found for cue effects on best-before products when generalizing over individual products. Also, no evidence was found for cue effects on smelling or tasting behaviour. For further interpretation of these results, we explored to what extent (cue effects on) choice, smell and taste behaviour differed across individual products (Figure 5).

When looking at use-by products past the expiry date, the observed cue effect on use vs. discard choices seems reflected in all four products (albeit somewhat enhanced for sweet peppers and chicken skewers relative to mango and tzatziki). Figure 5 additionally suggests product-specific cue effects on tasting behaviour: mango and tzatziki were tasted less often in the cue group than in the no-cue group (which is line with the intended behaviour in terms of food safety), whereas sweet peppers and chicken skewers were hardly tasted – if at all – in both groups. For best-before products past the expiry date, use frequencies were high for all four products, and relatively highest for bread sticks; for all products, differences between groups were minimal. As for tasting behaviour, the figure does suggest product-specific cue effects: sausage and bread sticks were tasted more often in the cue group than in the no-cue group, whereas tasting frequencies of hummus and brie differed much less between groups (although hummus was smelled more often in the cue group). Besides product-specific patterns for products past the expiry date, Figure 5 also shows differences in use and discarding behaviour between use-by and best-before products before/on the expiry date: salmon was used less often than carrots, and olives were used less often than almonds.

Taken together, these product-specific patterns suggest that participants did not only consider expiry dates when deciding whether or not to use products for the snack platter. Whereas cue effects on tasting behaviour went in the intended direction for some products, the inter-individual variation within product types and expiry date conditions seems to have prevented the detection of cue effects in the overall main analysis.

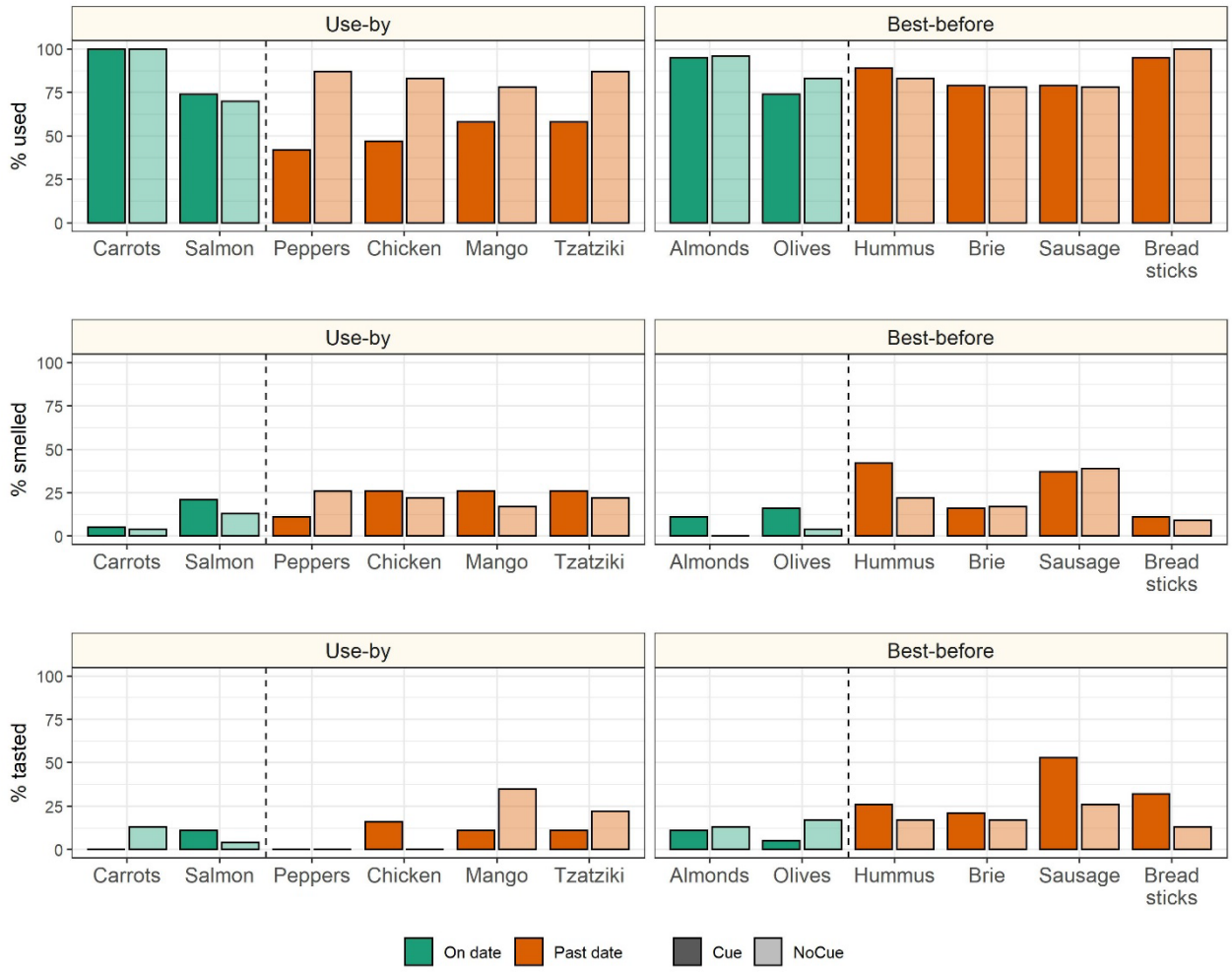

Figure 5 ***Choice (top), smell (middle) and taste (bottom) behaviour per product in cue (dark shades) and no-cue sessions (light shades). Green bars represent products before/on the expiry date; orange bars represent products past the expiry date.***

3.1.4 Individual variation

Besides exploring individual variation between products, we also explored to what extent use vs. discard choices varied between participants. Figure 6 shows the frequency distribution of participants in the cue and no-cue group over the number of products past the expiry date they used for the snack platter. As can be seen from the figure, in both groups the majority of participants used all best-before products past the expiry date (~60%). By contrast, the percentage of participants who used all use-by products past the expiry date was lower in the cue group (32%) than in the no-cue group (65%). This suggests that most participants were sensitive to the use-by cue (i.e. the cues discouraged the use of expired use-by products), although participants varied in how strongly they adhered to the cue: four participants discarded all four products, four participants discarded three products and four participants discarded two use-by products (all 20%); one participant discarded only one use-by product.

For best-before products, frequency distributions look highly similar for both groups, which strengthens us in attributing the group difference for use-by products to the cue rather than to general differences in waste behaviours.

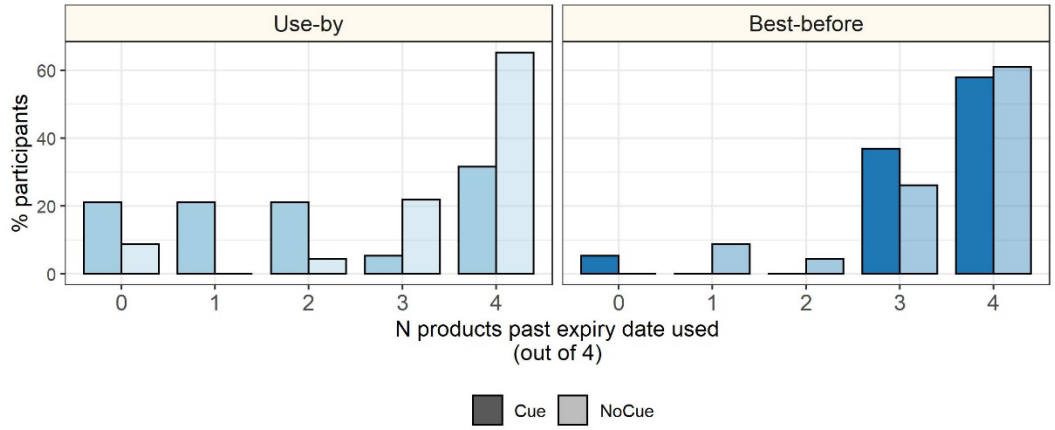

Figure 6 ***Frequency distribution of participants in the cue group (dark shades) and the no-cue groups (light shades) over the number of products past the expiry date they used (top), smelled (middle) and tasted (bottom).***

3.2 Questionnaire

This section summarises the most important findings from the questionnaire which was completed individually immediately after the food preparation task. A full overview of the results per question is provided in Annex 4.

3.2.1 The role of expiry dates during the food preparation task

When asked how much participants considered various aspects (expiry dates not explicitly mentioned) when deciding whether or not to use products on the snack platter, visual appearance of the products was considered most (M=5.5 out of 7), followed by taste (M=5.0) and smell (M=4.8); familiarity with the product (M=4.4) and on-pack information (M=4.4) were considered least. These results suggest that participants relied more on their senses than on the products' expiry dates (in line with the behavioural results). The percentage of participants who considered on-pack information was higher in the cue group (58%) than in the no-cue group (48%), which could suggest an effect of the additional date-marking information; however, this difference was not statistically significant (p=.60).

When asked whether they would have made the same choices if they had prepared the snack platter at home (for their household or for themselves), most participants indicated they would have used fewer products (71% would have used fewer products for themselves and 43% would have used fewer products for their household). First-mentioned reasons for not using products at home predominantly included personal preferences (79% of the cases; e.g. "*I do not like hummus"*), followed by quantity (13%; e.g. "*all products would be way too much. For example, I would only choose 1 kind of dip and 1 kind of meat*"); expiry dates or shelf life were never mentioned. A smaller number of participants said they would have used more products at home (29% would have used more products for their household, and 17% would have used more products for themselves). When asked to select which products participants would have used at home, products past the expiry date (red bars in Figure 6) were overall selected more frequently than products on the expiry date (green bars), confirming that expiry dates played a role in participants' decisions not to use products during the task, i.e. participants were more cautious with expired products than they would be at home. Indeed, the first-mentioned reasons for not discarding the selected products at home predominantly referred to expiry dates/shelf life (74%; e.g. "I would have taken the risk in terms of food safety"). Moreover, in the cue group, products past the use-by date (dark-red bars) were more often selected for home use than products past the best-before date (light-red bars), suggesting that participants were specifically more careful with use-by products during the task; this distinction between use-by and best-before dates was less apparent in the no-cue group.

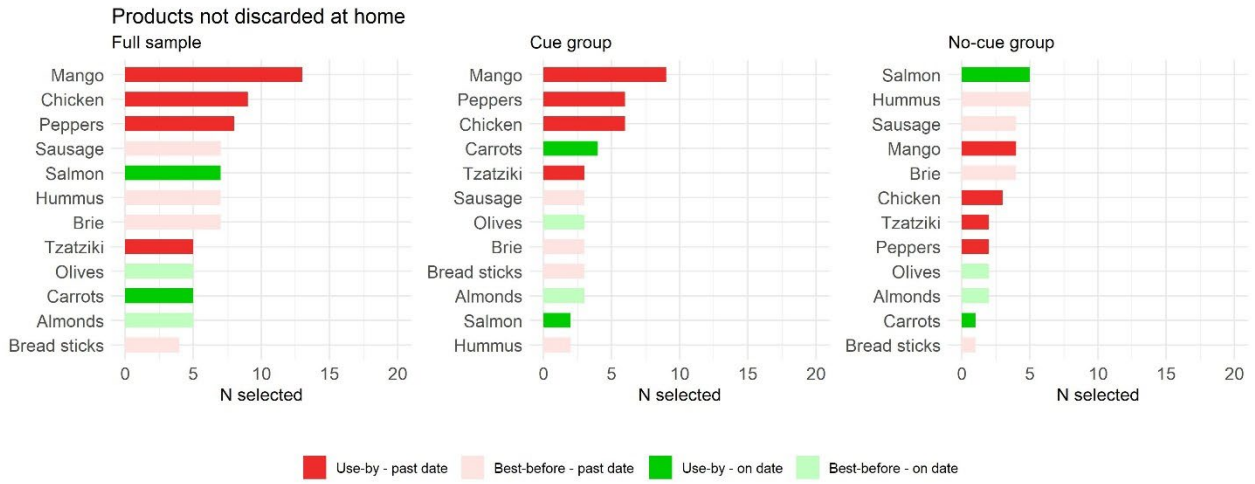

Figure 7 Frequency of selected products that would not have been discarded at home.

3.2.2 Attention to visual date-marking cues

To assess whether the visual date-marking cues had been noticed during the food preparation task, while minimizing response bias, a surprise recall task was included in the questionnaire. Sixteen symbols were presented on the screen, consisting of (a) the two visual date-marking cues, (b) twelve symbols that regularly occur on food product packages in the Netherlands (e.g. certification logos, packaging disposal icons, Nutri-Score), and (c) two fictive symbols (previously developed as potential date-marking cues). Half of these twelve common symbols did occur on one or more product packages during the food preparation task, the other half fid not. Participants were asked to select all the symbols they had seen on the product packages when preparing the snack platter.

As for the visual date-marking cues (stop-hand and arrow with senses), two participants in the cue group (11%) selected only the use-by cue and two (11%) only the best-before cue; three participants (16%) selected both cues. This suggests that the majority did not (consciously) notice the visual date-marking cues, despite their occurrence on all twelve product packages and their close proximity to the expiry dates (which had not gone unnoticed, as evidenced by the behavioural results and the questionnaire responses described in the previous section). In the no-cue group, the visual date-marking cues were never selected (correctly, since they received the products without these cues), except by one participant who selected the best-before cue (false alarm).

Results from the other 14 symbols (task-unrelated) suggest that attention to on-pack information was overall limited. Participants selected on average 1.4 (out of 7) symbols that did occur op products in the food preparation task (hits), and 0.7 (out of 7) symbols that did not occur (false alarms), yielding a near-chance discrimination performance (d' = 0.31). The plastic package disposal icon was selected most often (45% of participants), which could reflect a frequency effect (as this symbol occurred on multiple packages) but also hindsight reasoning (as most products came in plastic packaging). False alarms were mostly triggered by partially overlapping symbols. For instance, 33% of participants selected Nutri-Score A (which did not occur) whereas only 14% selected Nutri-Score C (which did occur). This seems to reflect educated guessing ("which symbols likely occurred?") rather than actual recall. We are inclined to interpret these results as 'attentional blindness', i.e., the goal of the task (preparing the snack platter) and the focus on expiry dates distracted attention away from other on-pack information. Participants in the cue group selected overall fewer task-unrelated symbols (M=1.5) than participants in the no-cue group (M=2.6) (which could speculatively be related to the additional date-marking information), but the differences between the two groups were not significant.

3.2.3 Understanding of 'use-by' and 'best-before'

Three questions were included to assess (cue effects on) participants' date-marking understanding. First, participants indicated for six products that were also included in the food preparation task (two use-by, four best-before) when they would eat these products at the latest (expressed as time periods relative to the expiry date). As shown in Figure 7, consumption limits of use-by products (salmon and carrots) were more restricted

than those of best-before products. Participants were especially cautious with salmon, which is in line with the behavioural findings. The figure moreover suggests that the cue group was more strict with use-by products than the no-cue group, which possibly reflects an effect of the previously encountered additional date-marking information ('do not use after date'); however, the majority of participants (cue + no-cue) would still eat these products past the expiry date. For best-before products, practically all participants (cue + no-cue) would eat these products past the expiry date, but consumption limits for sausage were more restricted than for olives, almonds and bread sticks (which the majority would still eat up to 2 months to one year past the expiry date).

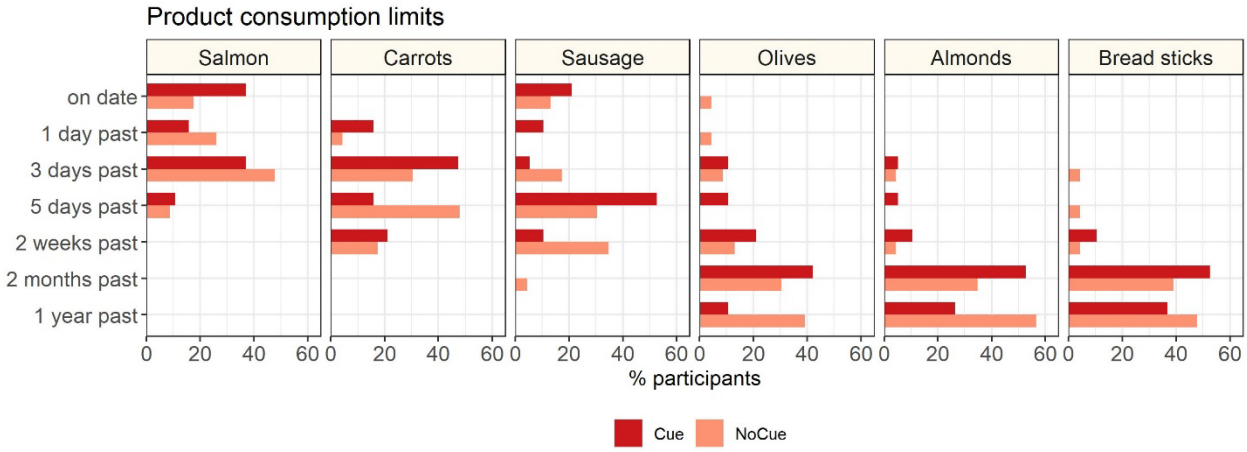

Figure 8 Frequency distribution of participants over consumption limits of use-by and best-before products.

Second, participants were explicitly asked whether they knew the difference between 'use-by' and 'best-before', and if so, to explain the difference in their own words. The vast majority of participants (86%) indicated to know the difference. About half of them correctly explained both terms; the other half of responses were not specific enough to be classified as correct (e.g. "one is the sell-by date, the other means you have to throw it away" – without specifying 'one' and 'other') or were repetitions of the terms that were already given in the question ("use-by and best-before") without any further explanation. No differences were found between the cue and no-cue group.

Third, participants performed a sorting task, in which they dragged-and-dropped ten food products (not included in the food preparation task) in either a 'best-before' or a 'use-by' bin. As shown in Figure 8, none of the products were unanimously classified as 'use-by' or 'best-before'. Only butter was classified as 'best-before' by all participants in the Cue group, but this seems to be a coincidence, given that products with the longest shelf-life, i.e. macaroni and sugar (sugar is on the Annex X list and does not even require an expiry date by law) were classified as 'use-by' products by about a quarter of participants. Note, however, that all participants but one (98%) placed sugar and macaroni in the same bin, and all but two participants (95%) placed sugar and minced meat (longest vs. shortest shelf life) in distinct bins. This suggests that the vast majority readily distinguished use-by from best-before products (and thus displayed a good conceptual understanding), but that about a quarter of participants confused the terminology of best-before and use-by.

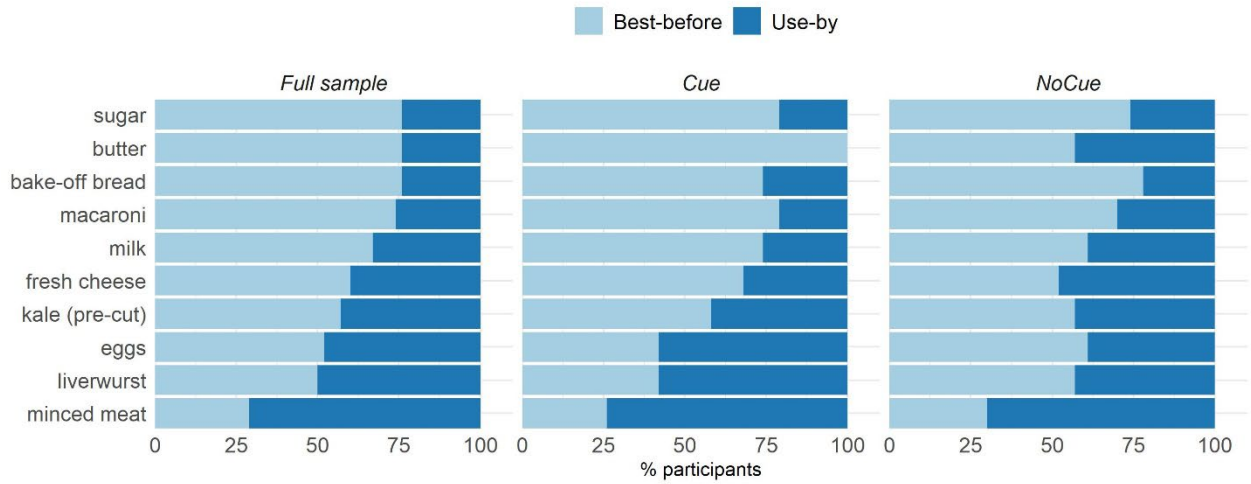

Figure 9 Relative frequencies of 'best-before' (light blue) and 'use-by' (dark blue) product classifications

3.2.4 Perceptions of additional date-marking cues

Immediately after the symbol recall task, participants were asked to indicate (guess) via an open question the meaning of the visual date-marking cues in isolation, i.e. without any textual explanation or an expiry date. To temporarily mask our specific interest in the date-marking cues, two task-unrelated symbols were also included in this question (for results, see Annex 4, slide 9). The best-before cue (arrow with senses) was correctly interpreted by the majority of participants (67%, as opposed to 33% answering 'I don't know'; there were no incorrect interpretations). This percentage was higher in the cue group (79%) than in the no-cue group (57%) (although the difference was not significant, p=.23). The meaning of the use-by cue (stop hand) in isolation was less straightforward: the majority of participants responded 'I don't know' (71%), with a higher percentage in the no-cue group (83%) relative to the cue group (58%) (again, this difference was not significant, p=.16). Three participants interpreted the cue as intended (two from the cue-group, one of whom selected the cue in the surprise recall task), whereas eight participants (five from the cue group) assigned it a different meaning (e.g. 'stop', 'read this first').

Later on in the questionnaire, the visual cues were introduced as examples of date-marking symbols, and participants were asked again to indicate what the symbols meant, now as a multiple-choice question ((a) look-smell-taste after date; (b) do not use after date; (c) other; (d) I don't know); they also indicated how clear and how useful they found the symbols on 7-point semantic differential scales. The best-before cue was correctly interpreted by almost all participants (39 out of 42; the other three participants responded 'I don't know'). The majority perceived it as clear (69%; M=4.9) and useful (50%; M=4.7). The use-by cue was correctly interpreted by 69% of participants (31% responded 'I don't know'). Only 14% of respondents perceived it as clear (M=2.9), and 36% as useful (M=3.7). Differences between the cue and no-cue group were not significant.

Lastly, the perceived value of additional date-marking information was assessed with three statements, once applying to information in general and once applying to visual information (the icons) specifically (Annex 4, slide 15). The majority of participants indicated to value additional date-marking information: 60% agreed that it would help to determine what to do with products past the expiry date, and 52% disagreed that expiry dates alone are self-explanatory. Although the vast majority of participants previously indicated to know the difference between use-by and best-before dates, 48% agreed that additional date-marking information would facilitate their understanding of expiry dates. The perceived value of visual information alone was somewhat lower, which suggests that using visual date-marking icons alone may be less desirable. Additional date-marking information was valued somewhat more in the cue group than in the no-cue group, but differences were not significant (p's>.23).

3.2.5 Participant traits

The final question of the questionnaire included three statements about food waste, and two statements about product expiry dates (one related to food planning, one to food safety). Almost all participants indicated to try to waste as little food as possible (90%) and to be conscious about the food they waste (95%); 81% indicated

that wasting food induces feelings of guilt. Although these responses suggest a highly food waste-conscious sample, since social desirability is pretty common for these type of questions (as also pointed out by one participant when filling out these questions: "who would disagree with these statements?"). Eighty-three percent of participants indicated to pay attention to product expiry dates when deciding what to eat. Lastly, two third of participants expressed a good understanding of expiry dates in relation to food safety: 67% indicated that they do not find it difficult to determine whether products past the expiry date are still safe to eat. Differences between the two groups were not significant (see Annex 4, slide 16).

3.3 Focus group discussions

3.3.1 Reflections on the food preparation task

When asked to share their experiences, most participants indicated to have enjoyed performing the task. Some expressed uncertainty about what to focus on; a few were worried whether they did it correctly. One participant mentioned: "*I had the feeling I was on the TV show 'Ready Steady Cook'*". Several participants mentioned that they had missed certain products (such as bread); multiple participants said there were several products they would not typically use or purchase themselves. In several sessions, participants started talking about the product expiry dates immediately. Various participants mentioned they had noticed that all products were close to or past the expiry date, others were triggered by the instructions given beforehand (where it was emphasized to use products 'as long as they are still good to eat'). The post-task questionnaire, which included multiple questions related to expiry dates and various symbols, likely triggered this topic as well. Experiences did not differ between the cue and no cue groups.

When asked which aspects they took into account when preparing the snack platter, personal preferences were brought up often (e.g. "*I never eat salmon, so I did not know how to present it*"). Some participants mentioned they did not select certain products because they would be difficult to eat without carriers or utensils (olives, tzatziki); others did not serve certain products because they found these did not combine well with the other products on the platter (e.g. mango). One participant mentioned: "*I did not want to combine two types of meat on the platter, so I selected just one*". Expiry dates were mentioned by the majority of participants (but not all: "*I trust on you researchers, so I did not check the expiry date and used everything*"). Some mentioned they checked expiry dates only for the meat and fish products. Someone from the cue group mentioned: "*I saw the text: 'Do not consume after expiry date' so I did not dare to use these products*". Many participants also mentioned that they took into account how the products looked (e.g. "*The olives did not look very tasty, so I left them out*"). The discussions confirmed that smelling and tasting behaviour differed across participants: some mentioned they smelled and/or tasted all products, others did not do so at all.

When participants were asked if they noticed anything particular about the products during the task (besides the expiry dates, which were again mentioned often), participants mentioned the many ready-to-eat and luxury products, the amount of plastic packaging, and that products all came from the same supermarket. Only few participants mentioned the extra information on the on the product stickers, with one person asking: "*Are these texts normally also on the product?*"

3.3.2 Perceptions of date-marking cues

After disclosure of the true study aim, various participants mentioned they had guessed the goal was probably related to expiry dates, but the connection with the additional date-marking information was not made. When the visual icons and explanatory texts were shown (on paper and on example product packages), one participant from the cue group said they had indeed noticed the extra text when checking the expiry dates, but assumed it was part of the private label. Most participants had not noticed the information at all; those who did, indicated that they saw the information on some but not on all twelve products. Some cue group participants did notice the text when checking the expiry dates, but missed the symbols completely.

In general, participants found the arrow symbol to be clear and helpful, while the hand was often considered as confusing and unclear. The accompanying text was found to be necessary to understand the symbols. Some participants mentioned that they would eventually recognize the arrow symbol even without the text, but the hand symbol required the text to be understandable. The arrow symbol was easier to notice

for participants, whereas the hand symbol was harder to detect. This was mentioned in both cue and no cue group discussions.

According to the participants, the symbols and accompanying texts as presented on the products were too small and not easily visible. Many individuals expressed their dissatisfaction with the size of the symbols, "*This would not be helpful if you do not have good eyesight*". Participants mentioned that they would not be able to see this without their reading glasses. They suggested that the symbols would be more effective if they were made more prominent with the use of colours. The arrow was seen as most useful of the two symbols, so people do not throw away food so quickly. Participants also expressed concerns, "*Symbols could be easily overlooked among the many symbols already present on product packages these days*".

The majority of participants in the cue group did not believe that the date-marking cues (would have) affected their behaviour during the task. They indicated that they already tasted and smelled the products as part of their usual routines and did not require additional guidance. A few participants in the cue group stated that the cues had affected their choices when selecting products for the platter. One of them mentioned; "*I was in doubt when I saw the hand symbol*", and therefore decided not to include those products on the platter, even though she would have used them at home. The arrow was a trigger for her to start tasting and smelling the other products. Another participant who did not notice the cues during the task, mentioned that the cues might have influenced her behaviour.

In the no-cue group, three participants indicated that the hand was less preferred since they did not feel they needed it: "*The hand was very compelling. As a consumer I can make my own decisions*." Responses to whether the visual cues would have affected their behaviour if these had been present on the product packages - were mixed in the no-cue group. Some participants mentioned that the arrow was nice, and it would prompt them to start tasting or smelling the products. Most participants saw potential in the symbols and thought they might be useful for others who tend to throw food away quickly.

3.3.3 Use-by and best-before dates

The discussions seem to indicate that part of the participants were familiar with the distinction between use-by and best-before dates and part not. Many participants stated that they simply look at the expiry date on food packages without paying attention to the type of date. Some participants were aware there were different types of dates but were unable to distinguish between them. One participant thought the meaning of the dates was reversed: "*You can smell and taste very perishable products easily, so these should have the look-smell-taste date*". Two participants (1 cue and 1 no-cue) believed that the date on the package indicated the sell-by date.

Opinions about the system of use-by & best-before expiry dates did not differ across cue and no-cue groups. Many participants indicated that the system with two different dates was confusing. Some mentioned a third kind of date, the production date used on packaged bread, which makes the system even more confusing. Most participants indicated to check the expiry date on products but admitted to pay no attention to the type of date. However, they indicated to be more cautious with the expiry dates of products like raw meat and fish. Some participants mentioned to be more careful with dairy products, whereas other participants thought that dairy is less vulnerable than meat. Multiple participants considered the best-before date as too conservative, leading to unnecessary food waste. One proposal was to use one date with different colors: black for best-before and red for use-by. One participant suggested a production date for products with a long shelf-life: "*Nothing will happen to long shelf-life products, so just give me the production date, then you can decide for yourself how long it will be good to eat*".

Participants' likelihood of checking the expiry date during shopping appeared to be dependent on their planning (the period for which they intend to use the products) and also on the type of products purchased. Many participants said to buy food that will be eaten the same or next day. In this case, they don't pay much attention to the expiry date and instead focus on the appearance of the food. However, for products intended to be used over several days or a week, participants indicated to pay more attention to the expiry date. Some participants stated to choose products with the longest expiry date to align with their planned consumption schedule, whereas others actively seek products with shorter expiry dates to avoid food waste and to be able to buy them with reduced prices.

Participants tended to pay less attention to the expiry dates when being at home compared to when they are shopping. Some participants stated to make sure that products will be eaten before the expiry date. Many participants mentioned to check products stored in the refrigerator, often by their senses of sight, smell and taste; they do not even check the expiry date, especially when packages are opened. For participants that

buy fresh food every other day, the expiry date at home was no issue at all, because they consume the foods within one or two days after purchase.

In general, participants tend to use the date on the package as a general shelf life date without distinguishing between best-before or use-by dates. Their action depends on the type of product (e.g. dairy) and whether the package is opened or still closed. Foods in closed packages are considered to stay good for longer. When checking products with a long shelf life, they rely on their senses to evaluate the safety of the food before consumption. The majority of participants tended to discard perishable foods like (minced) meat immediately when the date on the package has passed. However, some indicated to consume the products also 1-2 days after the expiry date. In such cases, they indicated to look, smell, and taste the foods, and to consume the foods themselves but perhaps no longer serving these to others. One participant mentioned that she would use (sliced) ham after the expiry date by heating it. Some participants indicated to store foods in the freezer to extend their shelf-life.

Most participants stated to be willing to eat expired foods themselves, but tend to be more cautious when serving these foods to housemates, friends, partners and children. They indicated to be most careful or refuse to serve expired foods to parents, elderly, guests, children or people they don't know well. One participant said: "*I would serve expired foods to my housemates and friends, but not to my girlfriend, for her I am more cautious*". The level of caution varied depending on the type of food, with more caution for products that are consumed raw. In contrast, there were also a few participants who said that it would make no difference for whom they prepare the food, so they would serve expired foods – when considered still good to eat - also to their friends, housemates and family.

4 Discussion

This pilot study aimed to investigate to what extent the presence of additional date-marking information (a visual symbol plus textual explanation) on food products affects consumer date-marking understanding and food waste behaviour in a realistic setting. To this end, consumers (N=42) performed a food preparation task (create a snack platter) under a cover story, using twelve food products with fictive expiry dates. Date-marking stickers either included additional date-marking cues or not (cue vs. no-cue condition; between-subjects). Upon completion of the task, participants filled out a questionnaire and engaged in an informal focus group discussion during which the snack platters were served and consumed. This chapter discusses the main findings by summarizing, comparing and interpreting the results from the different research activities. The strengths and limitations of the study are discussed in section 4.2; implications and recommendations are provided in section 4.3.

4.1 Key findings

Findings from the food preparation task partially confirmed our hypotheses. Results showed that additional date-marking information on use-by products affected disposal behaviour in the expected direction: products past the use-by date were disposed more often if extra information was present on the packages, which is desirable from a food safety perspective. To our knowledge, this is the first study demonstrating the effectiveness of extra on-pack date marking information on food waste behaviour beyond behavioural intentions or hypothetical choices. For best-before products, however, no evidence was found for the hypothesized cue effect on use versus discard choices. The desired impact on food waste reduction - which was observed in our previous online experiment (Zeinstra et al., 2021) - could thus not be demonstrated here. A similar asymmetric effect for use-by versus best-before dates has recently been reported in D'Amato et al. (2023), who found that date-marking education reduced consumers' willingness-to-pay for eggs past the use-by date, but had no effect on willingness-to-pay for eggs past the best-before date. This raises the possibility that effects of extra information about expiry dates are less pronounced or absent for best-before products. However, it seems premature to conclude that best-before cues are ineffective in food waste reduction for two reasons. First, the lack of evidence in our study seems due to an observed ceiling effect, i.e. best-before products were overall hardly discarded, leaving little room for a cue-related increase. This ceiling effect may be explained by the characteristics of our sample. The vast majority of participants reported to be highly conscious about food waste in the questionnaire. In addition, in the focus group sessions, several participants indicated to be "Too Good To Go" customers (thus actively committed to wasting less food). The behavioural bias in our current sample (i.e. the tendency not to discard expired foods) may not be representative for the behaviour of all (Dutch) consumers. This leaves the possibility open that best-before cues can effectively reduce unnecessary food waste in consumers with an opposite behavioural bias (i.e. discarding expired foods). However, additional research is needed to confirm this. Second, using distinct cues for use-by and best-before products highlighted the date-marking distinction, which would have been less obvious if a cue had been used for one type of date-marking only. This is important given that a considerable number of participants was found to confuse use-by and best-before dates in the survey, which is in line with findings from numerous studies in consumers worldwide (see for example (Patra et al., 2022; Turvey et al., 2021)). No differences were found between cue and no-cue groups concerning their understanding of the best-before and use-by terminology. This suggests that the cue encountered during the behavioural task did not improve understanding of the corresponding date-marking terms. It is possible that one encounter with this extra information about expiry dates was not enough to improve consumers' understanding. On the other hand, in order to properly handle expired use-by and best-before foods, understanding of date-marking terminology is in principle not needed, as long as consumers have a good understanding of which foods are potentially unsafe to eat and which are not (regardless of the corresponding terms). However, this is more obvious for some foods than for others. Whereas almost all participants readily distinguished typical use-by (minced meat) from typical best-before products (sugar; although not always assigning these the correct terms), there was more confusion regarding less typical foods (such as eggs, dairy). Whereas this confusion is exactly why European date-marking legislations have been put into place, our findings show that the date-marking terms currently

required by Dutch law (*tenminste houdbaar tot* 'at least preservable until', *te gebruiken tot* 'to be used until') do not meet their intended purpose, and call for a more explicit reference to the associated behaviour. Even in our biased sample (where most believed to know the meaning of use-by and best-before), the majority still agreed that additional on-pack information would be helpful in deciding what to do with expired foods. Although behavioural effects were limited to use-by products in our sample, using distinct cues for use-by and best-before dates may ensure that the intended (non-default) behaviour is also targeted in consumers with different behavioural biases. Moreover, it minimizes the risk that consumers generalize cue-induced behaviour to other food products (without cues) that are less readily categorized as best-before or use-by.

Observations of smelling and tasting behaviour during the food preparation task provided further insights in the processes leading up to participants' decisions to use or discard foods. Although foods were neither smelled nor tasted in the majority of cases, expired products were more likely to be smelled than non-expired products, and best-before products were more likely to be tasted than use-by products. This shows that *if* participants used their senses to evaluate food quality and safety, they did so as intended: they relied more strongly on their nose when evaluating expired foods, yet were more careful to taste foods that potentially bring about safety risks. No evidence was found for cue effects on smelling and tasting behaviour when averaging over products. However, two out of four products past the best-before date (sausage and bread sticks) were tasted more often, and two out of four products past the use-by date (mango and tzatziki) were tasted less often in the cue group relative to the no-cue group. These findings raise the possibility that the best-before cues encouraged, and the use-by cues discouraged participants to taste some expired products. The lack of evidence for group-level cue effects seems due to the other use-by (sweet peppers and chicken skewers) and best-before (brie and hummus) products, which were hardly tasted at all. We speculate that participants had other (date-unrelated) reasons not to taste these products. One plausible reason is that product packages contained relatively few chicken skewers and sweet peppers (six to eight), both of which are typically served as such (i.e. not cut into smaller pieces). Tasting (part of) one of these few pieces would have considerably reduced the to-be-served portion size. By contrast, product packages contained an abundant number of bread sticks and sausage slices, which allowed for tasting these products without consequences for serving. Participants may have taken this into consideration when preparing the snack platters.

Product-specific idiosyncrasies were also seen for non-expired products. As for use-by products, salmon was used less often, and smelled more often, than carrots; similarly, consumption limits (assessed in the questionnaire) were more flexible for carrots than for salmon. This suggests that participants were more cautious with animal-based than with plant-based use-by foods, which also followed from the focus groups, where use-by dates were associated with raw meat/fish and – to a lesser extent – dairy, but hardly ever with vegetables. Moreover, salmon was sometimes discarded for reasons unrelated to shelf-life (e.g. not wanting to serve or eat salmon slices without a carrier) which did not apply to carrots. For non-expired best-before products, olives were discarded more often than almonds, reasons for which were provided in the focus groups. Several participants indicated not to have the olives because of their unusual appearance (not pitch black, looking mat rather than shiny), smell (strange) and taste (soft texture) – all of which typical features of kalamata olives, which these participants appeared to be unfamiliar with.

The above findings combined show that expiry dates were not the only factor involved in participants' decisions to use or discard products, which underlines the complexity of empirically investigating the topic of food waste (D'Amato et al., 2023). Some food discard decisions were specific to the task/research context and are therefore unlikely to reflect everyday food waste behaviour. Moreover, various participants who did not serve (some) expired products on the snack platter indicated they would not have discarded these products at home. This could mean that these participants took the social context into account (i.e. they were more cautious when serving foods to strangers), but it could also reflect socially desirable behaviour. However, even if consumers may not display the same cue-induced behaviour in their daily lives, we believe that this should not be taken as an argument against the use of additional on-pack information. It seems preferable that consumers deviate from the desired behaviour based on conscious deliberations (choosing to take a food safety risk) rather than out of ignorance or confusion regarding expiry dates.

Results from the symbol recall task in the questionnaire showed that the visual cues on the product packages had gone largely unnoticed. The small size of the cues was also mentioned in the focus group discussions; it has been indicated as a barrier in previous studies as well (Chu et al., 2019; Deng & Zhang, 2019; Hersey et

al., 2013). Despite this lack of salience, however, effects of use-by cues on behaviour were still observed, which could indicate that the cues had an implicit (subconscious) effect. Alternatively, it could mean that participants attended more to the explanatory text than to the visual symbols. This seems plausible, as participants indicated in the questionnaire to value additional date-marking information in general, but visual images to a lesser extent. In the focus groups, several participants mentioned they personally preferred textual information, but that visual images may be more suitable to reach different target groups (e.g. low literate consumers). Also, it was mentioned that visual images may attract more attention – especially if presented in colour - on product labels full of information already. When evaluating the symbols separately, the best-before symbol (arrow with eyes, nose and mouth) was perceived as more clear than the use-by symbol (raised hand); this was confirmed in the focus group discussions, where participants indicated they needed the text to infer the meaning of the use-by symbol. It was suggested to initially use a combination of text and visuals, but that the visual symbol alone may suffice once consumers are familiarized with their meanings. Further research will be needed to validate this suggestion, and to investigate the effectiveness of visual and/or textual date-marking cues alone in various target groups.

4.2 Strengths and limitations

This is one of the very few studies that investigates strategies to improve consumer understanding of use-by and best-before dates and measures their impact on food disposal behaviour in a realistic setting. The study is unique in its approach and combination of methodologies. By using real products from various food categories (with on-pack date-marking information in realistic format) and investigating real-time product interactions in a realistic yet controlled food management context, we gained in-depth insights in the processes underlying consumers' decisions to discard foods, and how these are influenced by additional date-marking information. By having participants consume the prepared snack platters afterwards, we moved away from a hypothetical choice context: it ensured that participants took the consequences of their choices into consideration when deciding whether or not to serve the foods. Insights from the post-task questionnaire and focus group discussions helped to form a completer picture and nuanced our interpretation of the behavioral results.

By creating a plausible cover story related to the alternative research location, and by using commercial food products in their original packaging, we aimed to create a food preparation context that was as realistic as possible and would distract participants' attention away from our research purpose. Although a focus on product expiry dates could not be completely avoided (otherwise participants would have never considered the possibility of being provided with expired foods), participants were unaware of the manipulation of interest. Although several participants indicated to have noticed the date-marking stickers on the packages (from which they inferred the expiry dates had been manipulated), the additional cues were not considered to be part of the manipulation. This shows that the careful design of the date-marking stickers was successful. Stakeholders have previously indicated that the space at product packages is limited, making it challenging to add additional information. Our study shows that for the twelve products in the study, it was possible to add the information, but the small – but realistic - label size led to the fact that not all participants noticed the date marking cues during the task. It is possible that larger labels would have resulted in detecting more or stronger cue effects.

The relative small sample size and sample bias limit the generalizability of our findings. In our recruitment approach, we attempted to prevent selection bias by deliberately avoiding any associations with food waste and expiry dates. Despite these efforts, our sample happened to be generally committed to reducing food waste, believed to know the difference between use-by and best-before dates (although sometimes incorrectly), and over two thirds did not find it difficult to determine whether products past the expiry date are still safe to eat. This may explain the observed ceiling effect for expired best-before products (and the lack of evidence for the effectiveness of best-before cues). Providing extra information is less likely to exert any effect in well-informed consumers who already display the desired behaviour (at least for products with a best-before date). Therefore, we believe that the current results may more likely underestimate than overestimate the effectiveness of additional date-marking cues, as not all consumers will be equally confident in their safety judgments of expired foods. At the same time, it is important to note that without additional information, our sample displayed similar behaviour for all expired foods (no discarding) irrespective of the type of expiry date, which could reflect an improper understanding of the potential safety risks that expired use-by products can bring about (which are not always detectable by the human senses). In other words, our sample may in fact

not have been as informed as they indicated to be, which explains the effectiveness of the use-by cues found here. Moreover, even in our biased sample, additional date-marking information was valued by the majority. It seems reasonable to assume that the need for (and behavioural effects of) extra information will be even stronger in less educated and/or less food waste-conscious consumers – but additional research is needed to confirm this.

Another possible reason for the observed ceiling effect is the fact that the products used in our study were assigned a fixed expiry date. Although expiration periods were deliberately varied across products (one to two days for products with use-by dates; three days to over one month for products with best-before dates), the selected expiration periods may have been too short to raise uncertainty about their safety or quality. Future studies should investigate whether additional date-marking cues are more effective with longer expiration periods. This could be done via a within-product expiry date manipulation, which was not possible within the current small-scale study.

It should also be noted that our study included Dutch consumers only. Although date-marking regulations are the same across the EU, and date-marking confusion is found in consumers worldwide, it is possible that the cue effects observed in our study do not extend to (or are more pronounced in) other languages or cultures. Previous research has shown that there are differences between European countries in consumers' comprehension of the meaning of best-before and use-by labels (European Commission, 2015). Therefore, further research is needed to validate the effectiveness of additional date-marking information in other (European) countries.

The choice for the snack platter task ensured a realistic food preparation situation while placing minimal burden on the participants. By using ready-to-eat products, no extensive cooking skills were required; moreover, the additional time needed to prepare foods for consumption would have considerably increased the duration of the session without acquiring any relevant data between the moment of product selection and consumption. A downside is that not all products were equally familiar to participants, by which they could rely less on prior experiences to assess the quality and safety of these products. Our current findings may hence not generalize to more typical foods that are wasted most in Dutch households, such as bread, dairy and vegetables (Voedingscentrum, 2019, 2023). On the other hand, for additional date-marking cues to have an impact on food waste reduction, expiry dates need to be checked in the first place, which is impossible for foods that do not require an expiry date by law (such as bread and unpackaged vegetables). Future research should investigate which strategies are most effective to reduce waste of these food categories (for suggestions, see: https://samentegenvoedselverspilling.nl/tips-voor-thuis/). Lastly, note that the snack platter preparation task also triggered some unintended (date-unrelated) behaviours (such as not serving smoked salmon because no carriers were present) which may have restricted the (strength of the) cue effects in the current study. At the same time, valuable insights were gained from the product-specific behaviours. It demonstrated that consumers do not solely rely on expiry dates when deciding whether or not to discard foods (even in a research context where expiry dates are in focus – albeit subtly), which is likely the case in any realistic choice situation. As such, the choice for a more realistic task increased the external validity of our results.

4.3 Research recommendations

Several research recommendations can be derived from this research project.

First, because the cues in this study were a combination of visual and textual date-marking information, it would be interesting to investigate whether adding text alone will be equally effective. This is particularly interesting because the new regulations for best-before products requests the addition of extra text (not a visual cue) and our previous online experimental study indicated no differences between a visual cue combined with text or the text only condition (Zeinstra et al., 2021). Although a symbol may attract more attention on a product package full of text, text only may be easier to implement. In line with this, the recommendations of the respondents in our study about date-marking could also be tested in future studies, such as the effect of differently coloured dates or coloured date-marking icons on the product package. Besides variations in on-pack cues, other strategies beyond on-pack communication (such as educational campaigns) could also be tested in future studies.

Second, the results point to the fact that Dutch consumers have difficulties understanding the text that is currently required by Dutch law for date-marking (*Tenminste Houdbaar Tot* 'at least preservable until', *Te Gebruiken Tot* 'to be used until'). If additional words are needed to clarify these words currently preceding the date, it calls into question the added value of the existing date-marking regulations in terms of consumer empowerment. Future studies should investigate whether terms directly targeting the intended action (i.e. what to do with foods past the expiry date) alone, i.e. in the absence of currently required but confusing date-marking terms, are equally (or even more) effective.

A third topic that deserves further investigation is the relation between food waste behaviour and open (or secondary) shelf life. The on-pack date-marking cues in this study – as well as expiry dates in general – only apply to closed product packages, but they give no indication about what should be done with products after opening. This is especially relevant for food products are not consumed at once (unlike the products used here). During the focus group discussions, participants indicated to make a difference in handling between closed and opened product packages with respect to expiry dates, but this may not be clear to all consumers. It would therefore be highly relevant to further investigate how consumers could be assisted in this respect in order to further reduce food waste at the household level, without jeopardizing food safety issues. We are unaware of any scientific publications on this topic to date, making this a relevant and timely topic for further study.

Finally, it would be interesting to extend these results towards consumer groups of lower socioeconomic position, since over 70% of the respondents in our study was higher educated. Previous research does not show consensus about the relationship between socio-economic position and the amount of food waste (Simões et al., 2022; Vittuari et al., 2023). Therefore, it would be valuable to zoom in on a particular sub-behaviour of food waste: understanding and handling of expiry dates. How do these consumers deal with expiry dates and is extra information about date marking more, equally or less effective in this group?

4.4 Practical recommendations

Findings from this study provide indicative evidence for the effectiveness of consumer education about date-markings via on-pack communication. This underpins the recently accepted information amendment to EU Regulation No 1169/2011, requiring on-pack best-before dates to be followed by the words 'often good after'. Given the terminological confusion observed here (and in numerous previous studies) and the fact that many participants indicated to look, smell and taste also use-by products beyond their date, additional text would also be recommended for use-by dates, to prevent the possibility that consumers apply the best-before text also to use-by dates (potentially leading to safety risks). Moreover, based on our findings, it is recommended for additional explanatory text to explicitly target the required action, both for best-before dates ('look, smell, taste after date') and for use-by dates ('do not use after date'). One could even propose that such action-related language should replace (rather than be used alongside) the currently required date-marking terms. To maximize impact, it is advised to combine the text with visual symbols where possible, and to present the texts and images on the product package in a larger size than we did here. Moreover, given that consumers do not always check expiry dates (and/or ignore the preceding date-marking terms), it seems wise to combine on-pack communication with other forms of education, for instance through national campaigns (e.g. as part of the 'waste-free week', organized yearly by the foundation Food Waste Free United), or via taste lessons in schools.

When selecting the products for the current study, we came across several date-marking inconsistencies. For instance, on some products, expiry dates were preceded by abbreviations rather than the full terms required by law. Also, we observed multiple instances of products with both a use-by and a best-before date. Such inconsistencies complicate and diminish consumers' date-marking understanding. Moreover, we found that (seemingly) identical foods carried a use-by date if packaged as tapas, but a best-before date if packaged otherwise (e.g. tzatziki, sausage slices). This made us question the integrity of the use of use-by dates, raising the suspicion that use-by dates on tapas packages were used for marketing purposes (to create an impression of 'fresh' foods) rather than consumer empowerment. Such potentially insincere uses of use-by dates are to be avoided not only to minimize unnecessary food waste, but also to maintain and/or restore consumer trust

in the food industry. Therefore, more consistency in the use of these date labels is recommended to diminish confusion.

5 Conclusions

Findings from the current study provide initial evidence for the effectiveness of extra on-pack date-marking information in improving consumer food management practices in a realistic setting. The presence of visual and textual date-marking cues on the product packages discouraged consumers to serve foods that exceeded the use-by date, which is desirable from a food safety perspective. The desired impact of best-before cues in terms of food waste reduction could not be demonstrated, likely because expired products were hardly discarded in our study. However, observational insights suggest that best-before cues can encourage (and use-by cues can discourage) tasting of expired foods. Taken together, findings highlight the potential of on-pack communication for consumer education regarding expiry dates. Moreover, given that behavioural effects occurred irrespective of consumers' understanding of date-marking terminology, findings imply that educational date-marking strategies should explicitly target the associated actions (i.e. what to do with expired foods) to effectively impact food waste behaviours.

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Annex 1 Social Ethics Committee approval

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6706 kn Hollandseweg 1 Wageningen | The Netherlands

To whom it may concern

The following project proposal has been reviewed by the Social Sciences Ethics Committee (SEC):

Title: Effecten van visuele houdbaarheidscues op weggooigedrag bij consumenten: een real-life pilotstudie
Project team: Gertrude Zeinstra, Geertje van Bergen
Funding: The Ministry of Agriculture, Nature and Food Quality (LNV): BO-43-110-020
Period: September 2022 – July 2023 (Execution pilot study: Jan-Feb 2023)
Location: The Netherlands

The Committee has concluded that the proposal deals with ethical issues in a satisfactory way and that it complies with the Netherlands Code of Conduct for Research Integrity.

The approval number is: 2022-146-Bergen-2.

With kind regards,

Professor Dr Marcel Verweij
Chair Social Sciences Ethics Committee

DATE
05-12-2022

SUBJECT
Ethical approval of research project

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Annex 2 Focus group discussion guide

Focus group discussion guide

Small group discussions (4-5 participants, 2 groups per session);
2 snack platters are served per group

(Intro)
Thank you again for participating in this study! We would now like to discuss your experiences with the task you just performed. There are no wrong answers, we are interested in your personal opinions and experiences.

1. How was it for you to prepare the snack platter?
2. What do you notice when you look at these two snack platters? Differences? Commonalities?

Not that the snack platters are here to be consumed, so please feel free to take anything you like (you are allowed to talk with your mouth full)

3. What did you pau attention to when choosing which products to include on the snack platters?
    a. Were there any differences between the products?
    b. Wat were reasons for you to discard a product?
    c. Did you smell or taste the products first? Why (not)?
    d. Did you check the expiry dates or did you rely on (your experience with/feeling about) the type of product?

4. Did you notice anything particular about the products?
    a. (If so:) what did you think? How did you feel about that?

As you may have guessed, the goal of this research was slightly different from what we told you earlier. With this research we want to gain insight in how consumers deal with foods with different types of expiry dates. We have no disclosed this beforehand because we wanted to influence your 'natural' behaviours as little as possible. If we had told this in advance, you would have possibly focused much more on the expiry dates than you would normally do.
Note that none of the products you received were in fact expired, so all products on the snack platters are safe to eat. The original expiry dates were covered with stickers with a fictive expiry date. For half of the participants, these stickers included additional information to clarify the distinction between use-by and best-before dates. For the other half, this information was not included. We will compare product choices between these two groups. You were in a group that **did/did not** receive this extra information.

5. How do you feel about this?

6. Did you have a suspicion about the real study aim?

7. What was that suspicion based on?

8. **(Cue groups)**
    Your group received product packages with the following extra information *(show text and visual symbol on paper + 2 example products)*
    a. Have you ever seen something like this?
    b. Wat did you think of these symbols?
    c. Do you think the extra information on the packages played any role in your decisions to use or not to use products for the snack platter?
        - If yes, what role did it play? Was it the text, the symbol or both?
        - If no: why not?

(No-Cue groups)

The other groups received product packages with the following extra information *(show text and visual symbol on paper + 2 example products)*

d. Have you ever seen something like this?
e. Wat did you think of these symbols?
f. Do you think this extra information would have played any role in your decisions to use or not to use products for the snack platter?
    - If yes, what role do you think it would have played? What would have been different?
    - If no: why not?

At this moment the Netherlands has a system of two expiry date types: Use-by for perishable foods (food sfaty indicator) and Best-before for less perishable foods (quality incidator)

9. Did you know about this system ?

10. What do you think of this system of two expiry dates?
    a. Clear, understandable, confusing?
    b. When purchasing foods, do you pay attention to expiry dates, or not at all? And when preparing foods?
        i. If so: why, and when?
        ii. If not: why not?
    c. Wat do you usually do with products exceeding the best-before date? Does the same hold for products paste the use-by date?
    d. Does it matter who you preparet he products for (e.g. yourself or someone else)?

11. Are there any topics we have not yet discussed, or is there anything else you would like to mention?

Two final remarks from our side:

a. Should the real study aim (or the fact that we did not disclose this beforehand) be a reason for you not to participate in this research, please let us know and we will remove your data;
b. If you know any other persons who are participating in this study, please do not reveal the real study aim to them beforehand.

Many thanks for your participation!

Annex 3 Analyses of behavioural results

Table S 1 Logistic regression model summary: use vs. discard choices (full sample and per group): estimates (β), confidence intervals (SE) and p-values.

	Full sample			**Cue**			**No-cue**		
Predictors	*β*	*SE*	*p*	*β*	*SE*	*p*	*β*	*SE*	*p*
(Intercept)	2.13	0.38	**<0.001**	1.49	0.36	**<0.001**	2.48	0.49	**<0.001**
Group [cue]	-0.77	0.52	0.139						
Date [past expiry date]	-0.88	0.62	0.157	-1.06	0.45	**0.019**	-0.40	0.65	0.540
Product Type [Use-by]	-0.75	0.56	0.182	-1.32	0.41	**0.001**	-0.24	0.59	0.684
Date x Group	-0.82	0.62	0.183						
Product Type x Group	-1.14	0.56	**0.042**						
Date x Product Type	-1.26	1.23	0.305	-2.35	0.90	**0.009**	0.20	1.29	0.876
Date x Product Type x Group	-2.94	1.24	**0.018**						
N	42 $_{Participant}$			19 $_{Participant}$			23 $_{Participant}$		
	12 $_{Product}$			12 $_{Product}$			12 $_{Product}$		
Observations	504			228			276		
Marginal R^2 / conditional R^2	0.120 / 0.496			0.177 / 0.415			0.009 / 0.437		
log-Likelihood	-207.612			-109.058			-102.045		

Table S 2 Logistic regression model summary of smelling and tasting behaviour: estimates (β), confidence intervals (SE) and p-values.

	Smell			**Taste**		
Predictors	*β*	*SE*	*p*	*β*	*SE*	*p*
(Intercept)	-2.48	0.41	**<.001**	-2.44	0.35	**<0.001**
Group [cue]	0.77	0.67	.254	-0.06	0.55	.906
Date [past expiry date]	1.73	0.52	**.001**	0.85	0.46	.062
Product Type [Use-by]	0.24	0.43	.570	-0.97	0.42	**.020**
Date x Group	-1.29	0.81	.109	0.92	0.70	.188
Product Type x Group	-0.78	0.64	.223	-0.95	0.61	.122
Product Type x Date	-1.03	1.01	.307	-0.51	0.91	.572
Product Type x Date x Group	1.43	1.58	.368	-1.83	1.40	.191
N $_{Random}$	42 $_{Participant}$			42 $_{Participant}$		
	12 $_{Product}$			12 $_{Product}$		
Observations	504			504		
Marginal R^2 / Conditional R^2	0.137 / 0.569			0.095 / 0.446		
log-Likelihood	-198.768			-190.215		

Annex 4 Questionnaire responses

1. Which aspects did you consider when deciding whether or not to use products on the snack platter?

7-point scale, 1='not at all', 7 = 'very much'

	Full sample				Cue group				No-Cue group				*group comp.*
	M	*SD*	*% yes*	*% no*	*M*	SD	*% yes*	*% no*	*M*	*SD*	*% yes*	*% no*	
Visual appearance	5.5[a]	1.5	86	10	5.2[a]	1.8	79	16	5.7[a]	1.8	91	4	*p=.25*
Taste	5.0[a,b]	1.8	74	21	4.9[a,b]	1.7	74	26	5.0[a,b]	1.7	74	17	*p=.35*
Smell	4.8[a,b]	2.1	57	24	4.4[a,b]	2.2	47	32	5.0[a,b]	2.2	65	17	*p=.58*
Product familiarity	4.4[b]	2.2	60	38	4.0[b]	2.2	47	47	4.8[a,b]	2.2	70	30	*p=.99*
On-pack information	4.4[b]	2.3	52	40	4.6[a,b]	2.6	58	42	4.2[b]	2.6	48	39	*p=.23*

***Other aspects mentioned (open question)**: product diversity/combination with other products (4), expiry date (2), practical aspects/convenience (2), whether it can make you ill (2), hygiene (2), texture (2), nutritional value (1), animal-based (1), amount of processing (1), personal experience (1)*

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2. Would you have made other choices if you had prepared the snack platter...

.. for your household?	Full sample		Cue group		No-cue group	
	N	%	N	%	N	%
I would have made the same choices	12	29	4	21	8	35
I would have used more products	12	29	8	42	4	17
I would have used fewer products	18	43	7	37	11	48

... for yourself?	Full sample		Cue group		No-cue group	
	N	%	N	%	N	%
I would have made the same choices	5	12	3	16	2	9
I would have used more products	7	17	5	26	2	9
I would have used fewer products	30	71	11	58	19	83

At home (averaged)	All	Cue	No-cue
same choices	20%	19%	22%
more products	23%	34%	13%
fewer products	57%	48%	66%

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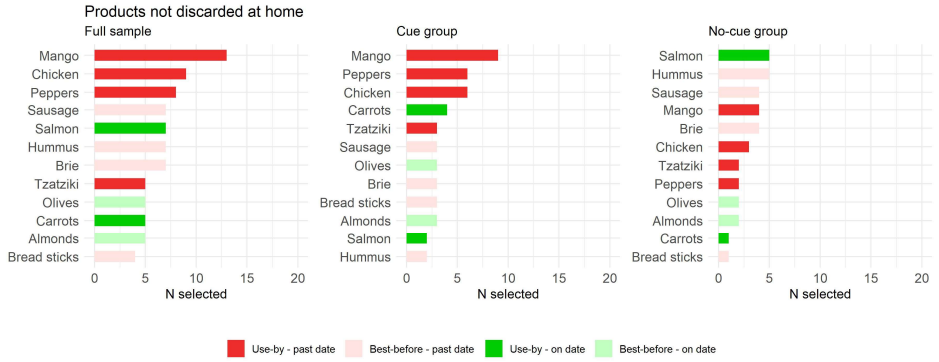
2.1. Which products would you have used at home and why?



First-mentioned reason	Full sample		Cue		NoCue	
	N	%	N	%	N	%
Expiry date/shelf life	14	74	9	70	5	83
Personal preference	2	11	1	8	1	17
Other (other's preference, convenience, combination w. other products)	*3*	*16*	*3*	*23*	*0*	*0*
TOTAL	19	100	13	100	6	100

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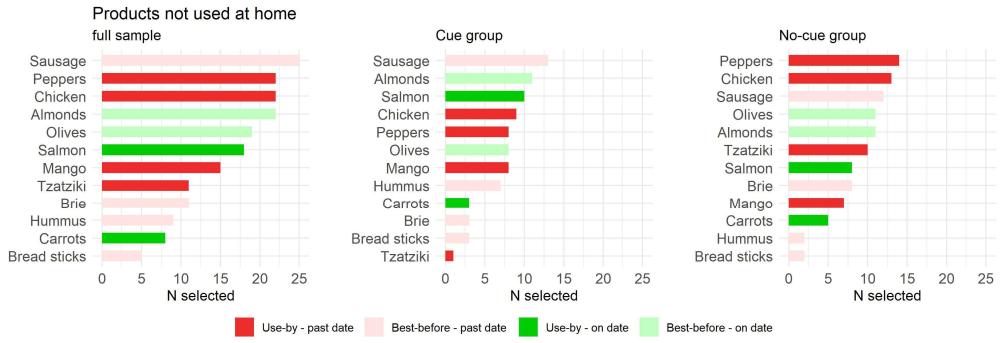
2.2. Which products would you not have used at home and why?



First-mentioned reason	Full sample		Cue group		NoCue group	
	N	%	N	%	N	%
Personal preference	38	79	15	83	23	77
Quantity	6	13	1	6	5	17
Other (other's preference, health, convenience, combination w. other products)	*4*	*8*	*2*	*11*	*2*	*7*
Expiry date / shelf life	*0*	*0*	*0*	*0*	*0*	*0*
TOTAL	48	100	18	100	30	100

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3. Select all symbols that you saw on one or more product packages while preparing the snack platter

Visual date-marking cues

(Did occur) (Did not occur)

Symbol	Full sample		Cue		NoCue	
	N	%	N	%	N	%
	6	14	5	26	1	4
	5	11	5	26	0	0

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3. Select all symbols that you saw on one or more product packages while preparing the snack platter

Other symbols: close matches

(Did occur)

HITS		Full sample	Cue	NoCue
NUTRI-SCORE ABCDE	*N*	6	2	4
	%	14.3	10.5	17.4
Beter Leven	*N*	9	3	6
	%	21.4	15.8	26.1
asc	*N*	12	3	9
	%	28.6	15.8	39.1

(Did not occur)

FALSE ALARMS		Full sample	Cue	NoCue
NUTRI-SCORE ABCDE	*N*	14	5	9
	%	33.3	26.3	39.1
Beter Leven	*N*	3	0	3
	%	7.1	0	13.0
MSC	*N*	7	3	4
	%	16.7	15.8	17.4

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3. Select all symbols that you saw on one or more product packages while preparing the snack platter

Other symbols (rest)

(Did occur)

HITS		Full sample	Cue	NoCue
	*N*	19	6	13
	%	45.2	31.6	56.5
	*N*	7	2	5
	%	16.7	10.5	21.7
	*N*	3	1	2
	%	7.1	5.3	8.7
	*N*	3	0	3
	%	7.1	0	13.0

(Did not occur)

FALSE ALARMS		Full sample	Cue	NoCue
	*N*	3	2	1
	%	7.1	10.5	4.3
	*N*	3	2	1
	%	7.1	10.5	4.3
	*N*	0	0	0
	%	0	0	0
	*N*	0	0	0
	%	0	0	0

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4. What do you think this symbol means?

Visual date-marking cues

		Full sample		Cue		NoCue	
		N	%	N	%	N	%
	Correct	28	67	15	79	13	57
	Incorrect	0	0	0	0	0	0
	don't know	14	33	4	21	10	43
	Correct	3	10	2	11	1	4
	Incorrect	8	19	5	26	3	13
	underspecified	*1*	*2*	*1*	*5*	*0*	*0*
	don't know	30	71	11	58	19	83

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4. What do you think this symbol means?

Other symbols

		Full sample		Cue		NoCue	
		N	%	N	%	N	%
NUTRI-SCORE A B C D E	Correct	14	33	6	32	8	35
	Incorrect	2	5	1	5	1	4
	Underspecified	23	55	10	53	13	56
	Don't know	3	7	2	11	1	4
Beter Leven	Correct	6	14	3	16	3	13
	Incorrect	0	0	0	0	0	0
	Underspecified	36	86	16	84	20	87
	Don't know	0	0	0	0	0	0

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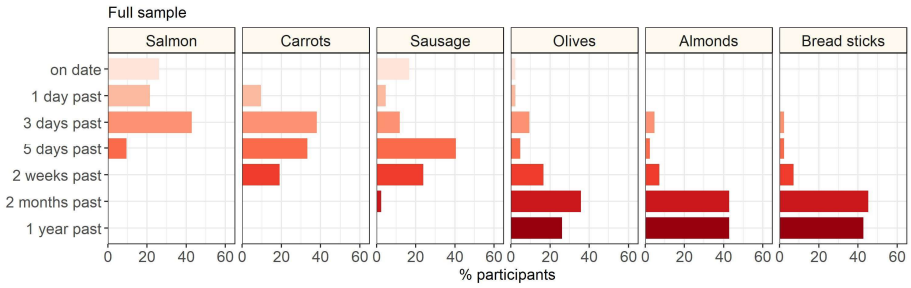
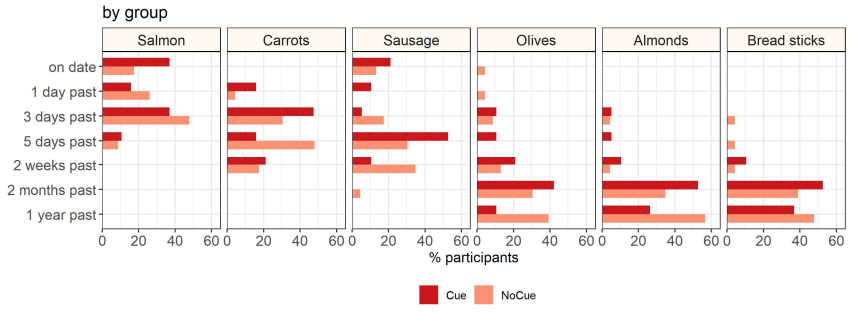
5. When would you eat this product at the latest?





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6. Do you know the difference between use-by and best-before dates?

	Full sample		Cue		NoCue	
	N	%	N	%	N	%
No	6	14	2	11	4	17
Yes (+ explanation)	36	86	17	89	19	83
Correct	*18*	*43*	*9*	*47*	*9*	*39*
Underspecified	*18*	*43*	*8*	*42*	*10*	*43*

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7. Sorting task: use-by vs. best-before products

	Full sample				Cue				No-Cue			
Product	Use-by		Best-before		Use-by		Best-before		Use-by		Best-before	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Minced meat	30	71	12	29	14	74	5	26	16	70	7	30
Kale (pre-cut)	18	50	24	50	8	58	11	42	10	43	13	57
Liverwurst	21	48	21	52	11	58	8	42	10	39	13	61
Milk	14	43	28	57	5	42	14	58	9	43	14	57
Fresh cheese	17	40	25	60	6	32	13	68	11	48	12	52
Butter	10	33	32	67	0	26	19	74	10	39	13	61
Eggs	20	26	22	74	11	21	8	79	9	30	14	70
Bake-off bread	10	24	32	76	5	0	14	100	5	43	18	57
Macaroni	11	24	31	76	4	26	15	74	7	22	16	78
Sugar	10	24	32	76	4	21	15	79	6	26	17	74

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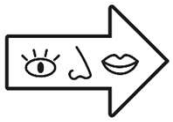
8. Perception of visual cues

Best-before



This symbol means		Full sample		Cue		NoCue	
		N	%	N	%	N	%
Look-smell-taste after date		18	95	21	91	39	93
Do not use after date		0	0	0	0	0	0
I don't know		1	5	2	8	3	7

This symbol is clear	M ± SD	4.9 ± 1.7	5.0 ± 1.8	4.9 ± 1.6
	% agree	69	74	65
	% disagree	24	26	22
This symbol is useful	M ± SD	4.7 ± 1.6	4.8 ± 1.8	4.6 ± 1.4
	% agree	50	58	43
	% disagree	19	21	17

7-pt Likert scales: 1=completely disagree, 7=completely agree

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8. Perception of visual cues

Use-by

This symbol means		Full sample		Cue		NoCue	
		N	%	N	%	N	%
Look-smell-taste after date		0	0	0	0	0	0
Do not use after date		29	69	14	74	15	65
I don't know		13	31	5	26	8	35

This symbol is clear	M ± SD	2.9 ± 1.7	3.3 ± 1.9	2.6 ± 1.7
	% agree	14	26	4
	% disagree	67	63	70
This symbol is useful	M ± SD	3.7 ± 1.8	3.8 ± 1.9	3.7 ± 17
	% agree	36	42	30
	% disagree	40	47	35

7-pt Likert scales: 1=completely disagree, 7=completely agree

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9. Perceived value of extra date-marking information

	Full sample			Cue			No-cue		
	M ± SD	% agree	% disagree	M ± SD	% agree	% disagree	M ± SD	% agree	% disagree
Additional information on the package...									
would help me to better understand expiry date	3.9±1.8	48	36	4.3±1.7	58	26	3.7±1.9	39	43
would help me determine what to do with products past the expiry date	4.5±2.0	60	29	4.6±1.9	68	21	4.3±2.0	52	30
is not necessary; the expiry date says enough	3.7±1.7	26	52	3.3±1.6	21	63	4.0±1.8	30	43
A clarifying image on the package …									
would help me to better understand expiry dates	3.5±1.7	38	48	3.9±1.6	53	32	3.1±1.7	26	61
would help me determine what to do with products past the expiry date	3.9±1.8	50	38	4.1±1.7	58	32	3.7±1.9	43	43
is not necessary; the expiry date says enough	3.9±1.5	26	45	3.9±1.3	26	53	3.9±1.7	26	39

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10. Participant traits

	Full sample			Cue group			No-cue group		
	M ± SD	% agree	% disagree	M ± SD	% agree	% disagree	M ± SD	% agree	% disagree
Attitudes toward food waste									
I try to waste as little food as possible	6.3 ± 1.2	90	5	6.1 ± 1.3	84	5	6.4 ± 1.1	96	4
Wasting food maks me feel guilty	5.7 ± 1.4	81	10	5.4 ± 1.7	79	21	6.0 ± 1.1	83	0
I am conscious about the food I waste	6.2 ± 0.9	95	0	6.1 ± 0.7	100	0	6.2 ± 1.0	91	0
Expiry date use and knowledge									
When deciding what to eat, I pay attention to product expiry dates	5.7 ± 1.4	83	10	5.4 ± 1.5	74	11	6.0 ± 1.3	91	9
I find it hard to determine whether food products past the expiry date are still safe to eat	3.0 ± 1.6	19	67	3.5 ± 1.5	21	53	2.7 ± 1.6	17	78

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To explore the potential of nature to improve the quality of life

Wageningen Food & Biobased Research
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Report 2453

The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 7,200 employees (6,400 fte) and 13,200 students and over 150,000 participants to WUR's Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.