



Consumer perceptions and disclosure needs regarding post-harvest additives

Geertje van Bergen & Gertrude G. Zeinstra

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Preface

It is estimated that about one third of all food produced globally becomes food loss or waste, which leads to economic, societal and environmental losses. In 2015, the United Nations have set the Sustainable Development Goal (12.3) to halve global food loss and waste by 2030. Innovations in post-harvest technology help contribute to this goal, amongst others with the development of post-harvest edible coatings (i.e. food additives) for perishable foods. In the US and many other countries, the application of edible coatings is allowed for all fresh produce, but in Europe, such post-harvest additives are allowed only on certain fruits with peels that are not typically consumed (e.g. citrus fruits, avocados). Extending their application to other produce (with 'edible' peels) would be desirable from a sustainability perspective, but it is unknown whether this is also desirable for consumers. The research in this report aimed to gain insight into European consumers' knowledge, perceptions and acceptance of post-harvest additives, as well as their needs and preferences regarding disclosure. The research activities were executed independently by Wageningen Food & Biobased Research, and commissioned and financed by Apeel Sciences.

The research in this report has been drafted and executed by Geertje van Bergen and Gertrude Zeinstra, researchers and project leaders of the Food, Health and Consumer Research group of Wageningen Food & Biobased Research. Rob Drent is gratefully acknowledged for leading and analyzing the focus group discussions. We thank Karen de Rosa Spierings for her contribution to organizing the focus group sessions. Also, we would like to thank all focus group participants and survey respondents for their participation in the study, and Sandra van der Haar and Annelies Dijk for reviewing the report.

We enjoyed the collaboration with the Apeel team and greatly appreciated their involvement and their feedback on the focus group guide and survey questions.

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Summary

About one third of all food produced globally goes either lost or wasted, which leads to economic, societal and environmental losses. Therefore, in 2015, the United Nations set the Sustainable Development Goal (12.3) to halve global food loss and waste by 2030. Apeel Sciences has developed a plant-based edible coating to prolong the quality and shelf-life of fresh fruits and vegetables (henceforth F/V) by reducing water loss and oxidation, which directly contributes to this goal. The application of edible coatings (regulated as food additives, hereafter referred to as 'additives') is allowed for all fresh produce in the US and various other countries; however, in Europe, such coatings are allowed only on certain fruits with peels that are not typically consumed (e.g. citrus fruits, avocados). Applying such edible coatings to other produce (with 'edible' peels) would be desirable from a sustainability perspective, but it is unclear whether this is also desirable to consumers, as little is known about how consumers perceive and appreciate the use of post-harvest additives on fresh produce. In addition, it is not clear whether consumers are aware of post-harvest additive use on fresh F/V. The more so, because – although EU legislations require additives to be declared in the list of ingredients of commercial food products – ingredient labelling is not required for all F/V.

This research project aimed to investigate European consumers' awareness, knowledge and perceptions regarding post-harvest additive use on fresh fruits and vegetables, as well as their wishes and needs regarding disclosure. To this end, two consumer studies were performed consecutively. First, a qualitative study was executed, comprising of six focus group discussions with Dutch participants (N=33). Based on the insights from these focus groups, a survey was developed and executed online among consumers from five European countries (The Netherlands, Belgium, Germany, Spain and France; N≈1,000 per country). In the survey, a between-subjects design was used to investigate the impact of various disclosure methods on consumer perceptions of post-harvest additives.

The focus group discussions showed that Dutch consumers had little awareness and knowledge about post-harvest additives: for many participants, the focus group session was the first time they heard about post-harvest additives. Perceptions and acceptance of post-harvest additive use on fresh F/V was found to strongly depend on the choice of words and the amount of information provided during disclosure. General descriptions (such as 'treatment', 'additive' and 'coating') were strongly rejected, evoking associations with chemical, unnatural and unsafe substances, which are counterintuitive in relation to fresh produce. Providing a full disclosure statement, with detailed information about the function, use purpose, plant-based origin and environmental benefits of post-harvest additives, considerably improved participants' perceptions. Yet, participants considered it unlikely that they would spend much time and effort to learn more about post-harvest additives themselves. Participants indicated a preference for concise disclosure messaging, which should come from an independent, objective, non-commercial source, that is easy to understand and focuses on the use purpose and benefits, as well as the (plant-based) origin of post-harvest additives (as a – heuristic – indicator for safety). It was also suggested to make more detailed information available on demand for those interested to learn more. Moreover, participants preferred disclosure at a central place at the point of purchase rather than on individual produce to prevent additional use of (plastic) packaging.

Survey findings confirmed that most European consumers were unaware of the use of post-harvest additives on fresh F/V and existing disclosure methods. From the four disclosure messages presented (which systematically varied between subgroups), ingredient disclosure messages (mentioning either the ingredient names or an E-number) were negatively evaluated: 20-25% of respondents found these messages positive and clear, and about a third of respondents found these reliable and useful. Alternative disclosure messages focusing on the use purpose of post-harvest additives (combined with a seal of approval from a European authority, or with additional statements on their environmental benefits and origin) were evaluated more positively: 50-80% of respondents found these messages positive, clear, useful and reliable, with the most detailed message being evaluated as best. After having read a full disclosure text about an example post-harvest additive (which was the same for all subgroups), the majority of respondents in all groups found its application to fresh F/V positive and useful. Although differences between subgroups were much smaller, the effect of the initial disclosure message did not completely disappear: subgroups who initially saw an ingredient disclosure message were not as positive as subgroups who initially saw an alternative disclosure message,

demonstrating that the negative impact of initial ingredient disclosure persisted in subsequent questions. As for disclosure needs, consumers displayed a strong wish for transparency. Eighty percent of survey respondents indicated they would want to know if post-harvest additives are used on the fresh F/V they purchase. An even higher percentage (95%) indicated that post-harvest additive use on fresh F/V should be disclosed to consumers, even if their safe use was approved by a European authority. Besides this strong wish for transparency, the survey results also showed that reading F/V labels is not common practice among European consumers, and less than half of respondents expressed the intention to look up more information about post-harvest additives via a QR code. Overall, the majority of respondents expressed trust in national and European food safety regulations (despite general feelings of suspicion regarding the food system). Also, consumer trust in many food information sources was high, with consumer organizations, farmers and scientists being trusted most.

Strengths of this research are the combination of qualitative (focus groups) and quantitative (survey) methods, which together led to a comprehensive picture, and the careful way in which a topic that is not top-of-mind to consumers was approached: the incremental information provision and the experimental (survey) design allowed us to investigate the impact of different disclosure methods on (changes in) perceptions and attitudes about post-harvest additives. It should be noted that the definition of post-harvest additives employed in this research (i.e. plant-based, edible protective layer), as well as the focus on Western-European consumers, may limit the generalizability of the findings. Also, as disclosure messages differed in various respects, it was not possible to specify which aspect(s) of the alternative disclosure messages contributed most to consumers' positive attitudes. Finally, intended or actual purchase and consumption behaviour were not assessed, but would be an interesting next step for future research.

In conclusion, this research has shown that European consumers have hardly any knowledge about post-harvest additives, and are unaware of current disclosure methods. Perceptions of post-harvest additives are generally positive, once consumers are provided with detailed information about their use purpose, environmental benefits and (plant-based) origin. In order to satisfy consumers in their need for transparency, while also taking into account their limited knowledge of additives and the lack of time and motivation to educate themselves in this respect, it is recommended:

- to always disclose the use of post-harvest additives;
- to use concise information focusing on the use purpose of post-harvest additives rather than mere ingredient or E-number declarations;
- not to present this information on individual products but to explore alternative disclosure strategies.

List of abbreviations

F/V	Fruit and/or vegetables
HBO	Hoger beroepsonderwijs (US equivalent: college education)
HFC	High food-conscious
LFC	Low food-conscious
M	Mean
MBO	Middelbaar beroepsonderwijs (US equivalent: junior college education)
SD	Standard deviation
WO	Wetenschappelijk onderwijs (US equivalent: scientific education - university)

1 Introduction

The current report shows the results of a consumer research project consisting of focus group discussions in the Netherlands and an online survey among respondents from five European countries. The research was commissioned and funded by Apeel Sciences and executed independently by Wageningen Food & Biobased Research. The primary objective of the research was to understand consumers' perceptions, acceptance and disclosure needs in relation to post-harvest edible coatings (i.e., food additives) that are used on fresh produce to prolong quality and shelf-life. Apeel has developed a plant-based coating that is currently on the market for fresh fruits and vegetables to prolong shelf-life of these products (by reducing water loss and oxidation), and as such can contribute to food loss and waste reduction throughout the supply chain. Within this report, the Apeel case is used as an example, as the research was focused on post-harvest treatments more generally.

Apeel was interested in getting in-depth insights into consumers' perceptions, trust, understanding, knowledge, perceived added value and expectations with regards to post-harvest additives, as well as consumers' needs and preferences with regards to information provision. Even though informing the consumer is not required by law in the majority of cases for post-harvest food additives used on fresh produce (requirements depend on whether and how F/V are prepared and/or packed; see GS1 in Europe, 2016), Apeel works together with suppliers and retailers to voluntarily disclose, where possible, such treatments to consumers. So, an important question was how information and communication will influence consumers' perceptions and expectations of such treatment.

While this report was initially written for Apeel Sciences, it is also relevant for any other reader who is interested in how consumers perceive post-harvest additives on fresh produce.

1.1 Background

About one third of all food produced worldwide is never eaten (Gustavsson, Cederberg, Sonesson, Van Otterdijk, & Meybeck, 2011). This food loss and waste has negative consequences for the environment, society and the economy (Chen, Chaudhary, & Mathys, 2020; FAO, 2013; Programme, 2021). Therefore, in 2015, the United Nations have set the Sustainable Development Goal (12.3) which aims to halve global food loss and waste by 2030 (<https://www.un.org/sustainabledevelopment>). EU countries have committed to this target, and it is also included in the EU Farm to Fork Strategy (2020).

Innovations in post-harvest technology help contribute to this goal, amongst others with the development of post-harvest additives for perishable foods. The application of edible coatings on the surface of fresh fruits and vegetables reduces post-harvest water loss and oxidation, by which the quality and shelf-life of these products can be substantially prolonged (Dhall, 2013). Whereas the application of edible coatings is allowed for all fresh produce in the US and various other countries, in Europe, such coatings are allowed only on certain fruits with peels that are not typically consumed (e.g. citrus fruits, avocados). Applying such coatings to other produce (with 'edible' peels) would be desirable from a sustainability perspective, but European governing bodies are hesitant to extend current legislations. An argument against the extension is the anticipated lack of support for the use of such coatings among European consumers. However, very little is known about how consumers perceive and appreciate the use of post-harvest additives on perishable produce.

To our knowledge, the only studies that have investigated consumer perception and acceptance of post-harvest additives on fresh produce focused on wax coatings on apples (Bucher & Malcolm, 2022; Bucher, Malcolm, Mukhopadhyay, Vuong, & Becket, Submitted; Cliff, Li, & Stanich, 2014). In an online survey among European and Asian consumers, Cliff et al. (2014) found that, at the start of the survey, respondents had no (complete) understanding of why apples are waxed, and 84% of respondents preferred unwaxed over waxed apples. However, the preference for waxed apples gradually increased as more information about the wax coating was provided: about 40% of respondents were more willing to accept waxed apples after having read information statements about their use purpose, natural content and food safety (against 42% who did not change their

preferred apple treatment). Bucher and colleagues (Bucher & Malcolm, 2022; Bucher et al., Submitted) found similar effects of information provision on acceptance of waxed apples among Australian consumers.

Although post-harvest additives have not received much attention specifically, there is a larger body of literature on the broader category of food additives. Multiple studies have demonstrated that consumer knowledge about food additives is limited, and that food additives have negative connotations, i.e., consumers perceive food additives as unnatural and artificial, and express concerns and distrust in terms of food safety and health (Bearth, Cousin, & Siegrist, 2014; Egolf, Hartmann, & Siegrist, 2019; Kaptan & Kayisoglu, 2015; Perito, Chiodo, Serio, Paparella, & Fantini, 2020; Szűcs, Szabó, Guerrero, Tarcea, & Bánáti, 2019; Zhong, Wu, Chen, Huang, & Hu, 2018). Moreover, several studies have shown that perceptions of food additives are sensitive to the way in which additives are described. For instance, a study by Mitterer-Daltoé et al. (2021) found that the majority of consumers perceived 'food antioxidants' as unhealthy, whereas the majority perceived 'natural food antioxidants' as healthy. Other studies have found that food additives are more negatively perceived if an E-number is added to their description (Evans, de Challemaison, & Cox, 2010; Siegrist & Sütterlin, 2017).

Taken together, findings from prior consumer research underline the importance of information provision and disclosure language in affecting consumer perceptions and acceptance of food additives.

1.2 Research aims

The overall objective of the current research project was to further extend consumer research on food additives by investigating European consumers' perspectives on post-harvest additives, and their application to fresh produce in particular. The three central aims were:

- 1) to gain insight in European consumers' awareness, knowledge and perceptions with regard to the use of post-harvest additives on fresh fruits and vegetables;
- 2) to investigate which conditions make the use of post-harvest additives on fresh produce acceptable or unacceptable for European consumers;
- 3) to identify European consumers' needs and preferences regarding post-harvest additive disclosure.

1.3 Overall research design and report structure

To achieve the above-mentioned research goals, two consumer studies were performed consecutively. First, a qualitative study was executed, comprising of six focus group discussions with Dutch participants (October 2021). The aim of this qualitative study was to explore the topic and get in-depth insights into consumers' awareness, knowledge, perceptions and acceptance of the use of post-harvest additives on fresh produce, as well as their needs and preferences regarding disclosure. This first study is reported in Section 2. Next, an online survey was developed and executed (May-June 2022) among consumers in five European countries (The Netherlands, Belgium, Germany, Spain and France). The aims of the survey were to validate the focus group results in a larger and international sample, and to examine whether there were country differences in awareness and knowledge about post-harvest additives, in consumer criteria for acceptance, and in disclosure needs and preferences. This second study is reported in Section 3. Findings from both studies are brought together and discussed in Section 4. The overall study design was reviewed and approved by the institutional review board of Wageningen University (Annex 1).

2 Qualitative study: Focus group discussions

2.1 Method

The aim of the focus group discussions was to get in-depth, rich and potentially new (unknown) insights into consumers' awareness, knowledge, perceptions and acceptance of the use of post-harvest additives on fresh produce, and their wishes and preferences regarding disclosure. Focus group discussions were chosen because qualitative research is appropriate to explore a topic, where respondents can give meaning to their experiences in their own words (Jeanfreau & Jack, 2010; Maso & Smaling, 1998). In addition, focus group discussions are valued because respondents can react and build upon each other's responses, thereby leading to richer and more in-depth information (Morrison-Beedy, Côté-Arsenault, & Feinstein, 2001; Stewart & Shamdasani, 1990).

The focus groups discussions were executed in October 2021. Six sessions were held online (via Zoom), and were led by a professional moderator. Each session had a duration of approximately 120 minutes, and was attended by at least one project team member, who listened and took notes, but did not actively participate in the discussion (camera and microphone were disabled). The moderator mentioned their presence to the participants at the start of the session. All sessions were audio-recorded for analysis. All participants received a monetary compensation for their participation.

2.1.1 Participants

Participants for the focus group discussions were recruited via a market research recruitment agency. The topic of post-harvest additives was deliberately not mentioned in the invitation (to avoid biased responses), but the purpose of the research was stated in global terms: to gain insight in how consumers think about and deal with various types of F/V, and what they pay attention to when purchasing and consuming fresh F/V. We aimed to include a diverse group of consumers, varying in age, gender and background. Five participants plus one extra were scheduled for each focus group discussion to ensure inclusion of at least 30 participants. Three age categories were specified to guarantee inclusion of various ages: 18-35 years, 35-50 years and 50-65 years. Other inclusion criteria were being responsible for purchasing at least 50% of the weekly groceries, and regularly purchasing fresh fruits and vegetables (at least weekly). Participants were divided into two groups based on their level of 'food consciousness', which was determined on the basis of their responses to six statements regarding their food purchase and consumption behaviour in the past six months. These statements were derived and slightly adapted from the *actual sustainable behaviour scale* (Laureati, Jabes, Russo, & Pagliarini, 2013): (1) eating a warm meal without meat; (2) purchasing local foods; (3) purchasing seasonal foods; (4) avoiding genetically modified foods; (5) avoiding preservatives in foods; (6) eating organic foods (*answer categories: 1= 0 times; 2= 1-3 times per month; 3= 1-2 times per week; 4= 3-5 times per week; 5=daily*). Participants who scored ≥ 3 on minimally four statements were categorized as *high food-conscious* (=HFC) consumers; those scoring ≥ 3 on maximally two statements were selected as *low food-conscious* (=LFC) consumers. Responses to two additional statements (avoid plastic packaging; choose food brands that employ sustainable business practices) and a shortened version of the food choice motives questionnaire (Onwezen, Reinders, Verain, & Snoek, 2019; Steptoe, Pollard, & Wardle, 1995) were used to further characterize the HFC and LFC groups.

Table 1 Focus group participant characteristics.

	High food-conscious	Low food-conscious*
Group constellation		
Sample size N (N females)	17 (11)	16 (11)
Session 1 (18-35 yrs)	6 (4)	6 (4)
Session 2 (35-50 yrs)	5 (3)	4 (3)
Session 3 (50-65 yrs)	6 (4)	6 (4)
Age		
M ± SD years	42.8 ± 14.5	42.4 ± 17.6
Education level		
N (%) participants		
MBO (junior college education)	5 (29)	8 (53)
HBO (college education)	6 (35)	5 (33)
WO (scientific education)	6 (35)	2 (13)
F&V purchase frequency		
M ± SD times per week	2.9 ± 1.3	2.3 ± 0.9
F&V purchase locations		
N (%) participants		
retailer	16 (94)	14 (93)
farmer's market	8 (47)	5 (33)
local grocer	5 (29)	1 (7)
organic grocery store	5 (29)	0 (0)
online	1 (6)	3 (20)
ethnic grocery store	3 (18)	0 (0)
Food choice motives		
M ± SD		
Health	6.6 ± 0.3	5.5 ± 0.7
Natural content	5.7 ± 0.8	3.8 ± 1.8
Ethical concern	5.9 ± 0.7	4.2 ± 1.8
Convenience	5.1 ± 0.8	5.0 ± 1.6
Avoid plastic packaging		
N (%) participants		
Never	1 (6)	3 (20)
Rarely	3 (18)	7 (47)
Sometimes	3 (18)	4 (27)
Often	7 (41)	0 (0)
Always	2 (12)	1 (7)
Choose food brands that employ sustainable business practices		
N (%) participants		
Never	0 (0)	5 (33)
Rarely	7 (41)	9 (60)
Sometimes	3 (18)	1 (7)
Often	5 (29)	0 (0)
Always	2 (12)	0 (0)

*Descriptive statistics of the LFC group are based on 15 participants, because responses from one participant (who joined last-minute to replace a no-show) are missing.

In total, 36 consumers (18 HFC, 18 LFC) were scheduled for the focus group discussions (three HCF and three LC sessions, covering the three age categories). Three consumers did not participate in the discussions (two no-shows, one drop-out due to a technical issue during the session), yielding a final sample of 33 participants (17 HFC, 16 LFC). Their average age was around 42-43 years, and two thirds were female (N=22; 67%). Participants indicated to purchase fruit and vegetables 2-3 times per week, with the supermarket (retailer) as most common purchase location. The HFC group had higher scores for food choice motives related to health, natural content and ethical concern. A higher percentage of HFC participants indicated to avoid plastic packaging often or always (53% versus 7% for LFC), which was also true for choosing brands that employ sustainable business practices (40% for HFC versus 0% for LFC). These differences support that the two groups differed in their level of food-consciousness. The characteristics of the HFC- and LFC samples are summarized in Table 1.

2.1.2 Content of focus group discussions

To ensure consistency in data collection (Morrison-Beedy et al., 2001), a semi-structured guide was developed for the focus group discussions, based on three central topics with the following questions (the full discussion guide is provided in Annex 2):

Awareness & knowledge

- What do consumers know about post-harvest additives on fresh produce?
- Are they aware that additives are used on fresh produce (i.e., do consumers expect additives to be applied to conventional produce)?
- Do they perceive different categories of additives that may be applied to fresh produce?

Attitudes

- What do consumers think about these (different categories of) additives?
- Which factors influence consumers’ acceptance of additives?
- Which criteria/aspects make the use of additives on fresh produce acceptable or unacceptable?

Transparency & preferred disclosure information

- How do consumers want to be informed about safe post-harvest additives on fresh produce?

After an introduction round and a general discussion on F/V purchase and consumption behaviour, a PowerPoint slide containing various types of fresh fruits (e.g. lemons, pineapple, grapes, strawberries) and vegetables (e.g. cucumber, pumpkin, peppers, eggplant) was shown. Some of these produce were packaged (e.g. plastic foil, net, carton) while others were not; some produce contained stickers or labels (e.g. product brands, PLU codes, certification labels) while others did not (see Annex 2, slide 13). This slide was used to make the discussion about F/V more concrete and enhance participants’ engagement. During the discussion, post-harvest additive disclosure was built up gradually: the moderator showed information statements about post-harvest additives on the screen in a piecemeal fashion, moving from the general notion of ‘treatment’ to ‘food additive’ to a highly detailed description including information about the origin, function and potential user benefits of post-harvest additives (Table 2). This was done to assess participants’ (prior) knowledge about post-harvest additives and to explore the influence of additional information on perceptions and acceptance.

Table 2 *Post-harvest additive disclosure statements presented during the focus group sessions.*

Stage	Disclosure statement
1	‘Some of these stickers and labels indicate that the produce have undergone some form of treatment after harvest’
2	‘These stickers and labels indicate that a food additive has been applied to these produce after harvesting. With food additive we mean substances that are added to foods to improve a certain property of that food. Some of these additives are also referred to as ‘edible coatings’ since they are food ingredients that may be safely consumed along with the produce.’
3	‘An example of a post-harvest treatment is adding a plant-based coating to the skin of fruit and vegetables that you cannot taste or smell. This plant-based protection holds the moisture in the product longer, while oxygen remains outside. This way, the product can be kept 2-3 times longer. As such, it contributes to a sustainable food chain, improves food quality and reduces food waste. The coating is made of plant-based material from the peel, seeds and flesh of fruit and vegetables that we already eat.’

2.1.3 Analysis

A thematic analysis was carried out by the focus group moderator based on the audio recordings of the sessions and the notes taken by the project team members. The results were analysed for similarities in responses or themes that were mentioned by both groups (HFC versus LFC) or by all participants, as well as for differences between groups (HCF versus LFC) or individuals. The results were presented and discussed with the research team to check interpretations and conclusions.

2.2 Results

This section summarizes the key findings from the focus group discussions. The full report written by Rob Drent, including quotes from respondents, is enclosed in Annex 2.

2.2.1 General: F/V purchase and consumption behaviour

Participants mentioned the supermarket as their main point of purchase for fresh F/V. They indicated to purchase fruits typically in larger quantities, for multiple days and without a fixed consumption moment in mind. By contrast, vegetables are typically purchased with a fixed meal in mind and in quantities specific to that meal. Fruits are usually stored at room temperature (in a bowl as this looks appealing), whereas vegetables are mainly stored in the fridge. As such, most participants acknowledged that fruits are more prone to turn bad and be discarded than vegetables. Whereas all participants shared the feeling that food should not go to waste, they varied in how much conflict they feel when fresh F/V are wasted.

2.2.2 Awareness and knowledge

Both LCF and HCF consumers showed very little awareness of post-harvest additives. Most participants heard the term 'food additive' for the first time during the session, and this topic was not mentioned spontaneously. A general idea that fresh fruits/vegetables may receive some kind of treatment existed, but reactions were largely restricted to treatments during growth (e.g. use of pesticides), during harvest (harvest before full ripeness) or during transport (cooling, using plastics). When discussed further, respondents assumed that these treatments could serve two functions: aesthetics to make the fruit/vegetables look appealing or sustainability to keep it fresh for longer. Plastic packaging was mentioned often during the discussions, which evoked negative reactions (redundant, annoying, bad for the environment) among the majority of participants. Only few participants mentioned that plastics may serve to protect or extend the shelf life of fresh produce. Some participants were aware that some fruits (lemons, apples) received a wax coating, which was mostly assumed to serve an aesthetic purpose (making these produce look more shiny or colourful).

The presence of stickers and labels on fresh produce was thought to serve several functions (e.g. names or PLU codes indicating product varieties to facilitate recognition for cashiers; logos indicating fair trade or organic production), but that such stickers could also indicate a post-harvest treatment was widely unknown. Respondents generally did not feel that stickers had any personal added value, they even may be annoying to peel off. As for ingredient labels on packaged produce (e.g. a net of lemons), most indicated to have never paid attention to the information on these labels, as they saw no obvious reason or need to check the ingredient list of natural/unprocessed foods ('what you see is what you get'). Only a few (HFC) consumers indicated to have ever looked at such labels in more detail, but no link was made with post-harvest treatments. Due to the overall lack of awareness of postharvest additives, different categories of post-harvest additives were not further discussed.

2.2.3 Attitudes

The gradual build-up of information about post-harvest additives was found to strongly affect participants' attitudes toward post-harvest additives. Information on F/V having received some 'treatment after harvest' without any further explanation was received with surprise (a completely new message for most), mistrust and uncertainty about what was exactly meant with this. The term elicited associations with pesticides, chemicals and unnatural processes. When the word 'food additive' was introduced, reactions were even more negative:

the word 'additive' started alarm bells and led to anxiety. Both the terms 'food additives' and 'coating' evoked associations with chemical, unnatural substances (few participants made a connection with E-numbers), which were perceived as (highly) undesirable due to the stark contrast with the assumed naturalness of fresh F/V. Respondents also indicated that the term 'may be safely consumed' was not backed-up or proven, and as such did not reassure. When given a choice to buy produce with or without additives, respondents generally preferred untreated produce over prolonged freshness.

When a more detailed information statement about post-harvest additives was provided, however, initially negative attitudes turned 180 degrees. The message offered concrete, practical information and reassured on food safety, sensory experience and naturalness. Information about the plant-based origin of the additives was positively received, largely taking away initial concerns regarding health and food safety. Moreover, the message made the function of the coating concrete, and explained its use purpose and environmental benefits, offering participants an easy way to contribute to these benefits. This all had a reassuring effect on the majority of participants. At the same time, the reliability of the statement was questioned: a 3 times longer freshness was perceived as less credible, and questions remained about the source (who is making this claim and how can it be checked?). Participants (mostly in HFC groups) expressed a desire for a third party to provide independent evidence. When asked what would be considered a trustworthy source in this respect, participants mentioned independent, objective, non-commercial parties, like research institutes and consumer-oriented organizations (*Consumentenbond*) and television programs (*Keuringsdienst van waarde*). Retailers and producers were considered unreliable sources because of their potential commercial interest. After having received all disclosure information, many participants indicated to still prefer untreated over treated produce (although some noted that this was probably a utopic idea), reflecting the strongly engrained idea that fresh produce should be as natural as possible.

2.2.4 Transparency and preferred disclosure information

Although most participants had never heard of post-harvest additives prior to the discussion, the majority was not surprised that post-harvest additives are already being used on (some) fresh produce, reflecting a general attitude about food nowadays: consumers often do not get to see what actually happens to the foods they consume. The majority showed low involvement with the topic and had a rather laid-back attitude. They expressed trust in national and European food safety regulations, and relied on the pragmatic notion that, if post-harvest additives would be harmful for the public health, it would have been banned already. Few participants indicated that being informed about post-harvest additives would make them more cautious when purchasing fruits/vegetables in the near future (i.e. paying closer attention to ingredient labels or information on packaging). However, most participants admitted that this knowledge would probably not change their food choice behaviour, their awareness was only temporarily raised (during the session). Checking every single produce before purchase is seen as too much of a hassle and too cumbersome in daily life. The majority did not want to be overloaded by information and would rather rely on an independent organisation to regulate this.

When discussing possible disclosure scenarios, participants expressed a preference to learn about the use of post-harvest additives at the point of purchase (i.e. where food choices are made), preferably at a central place (on or near the shelf) rather than on individual produce to prevent additional (plastic) packaging. Disclosure channels should be multi-modal, such as signs/information boards at the produce aisle, leaflets, and QR codes which can be scanned by interested consumers. Moreover, information should be provided by an independent, objective, non-commercial source. When prompted to give input on the design of a symbol or logo to communicate the presence of post-harvest additives, participants indicated that such a sign should be reassuring (e.g. use of green colours to communicate naturalness and food safety, containing a seal of approval from a trusted local or national source) and easy to understand (e.g. a shield to communicate 'protection', containing a single word or a few words at most).

2.3 Conclusion

In conclusion, the focus group discussions showed a low level of awareness and knowledge about post-harvest additives among Dutch consumers: for many participants, the focus group session was the first time they heard about post-harvest additives. Perception and acceptance of post-harvest additives on fresh F/V was found to strongly depend on the choice of words and the amount of information provided. Short, general descriptions (such as 'treatment', 'additive' and 'coating') were strongly rejected, evoking associations with chemical, unnatural and unsafe substances, which are counterintuitive in relation to fresh produce. Providing detailed information about the origin, function, use purpose, naturalness (as safety indicator) and benefits of post-harvest additives seems crucial to overcome these negative attitudes. At the same time, Dutch consumers seem unwilling to spend the time and effort needed for a more informed and nuanced perspective (they rather rely on 'beacons of trust'), which presents a challenge with respect to transparency. The most preferred disclosure strategy would be to communicate an easily accessible, easy to process and reassuring disclosure message from a trusted source to all consumers – focusing on the benefits and naturalness as a (heuristic) indicator for safety - and to provide more detailed information on demand for those interested and willing to learn more. The information should be on or near the shelf rather than on individual produce to prevent additional (plastic) packaging.

3 Quantitative study: European survey

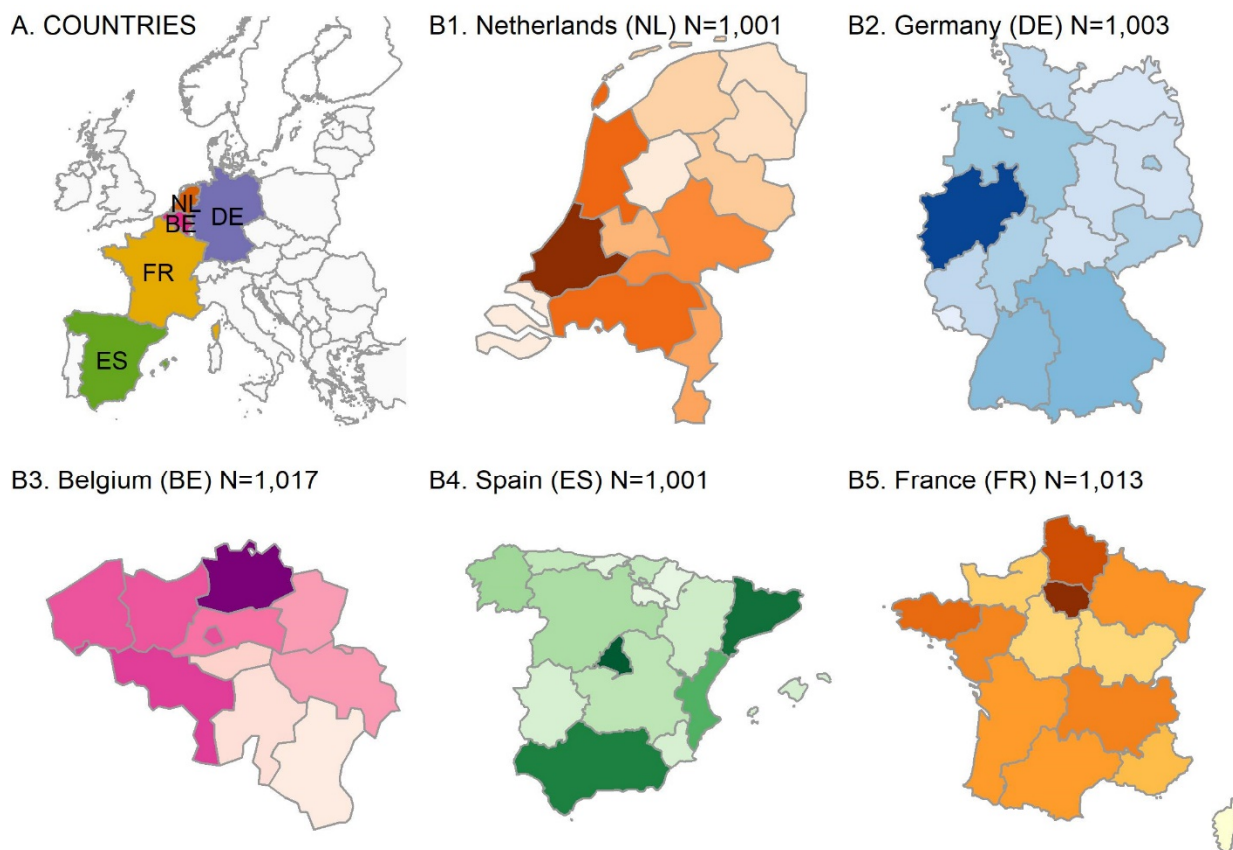
3.1 Method

To confirm (or disconfirm) and further specify the findings from the focus group discussions in a larger and international population, an online survey was conducted among consumers in five European countries (the Netherlands, Germany, Belgium, Spain and France) in May and June 2022. The following research aims were defined:

1. To validate consumers' low level of awareness about the use of post-harvest additives on fresh produce;
2. To explore which benefits of post-harvest additives would provide value to consumers (regardless of their knowledge about additives);
3. To investigate disclosure needs and wants in relation to post-harvest labelling:
 - a. How do consumers evaluate different forms of disclosure?
 - b. Do consumers want and/or expect to see a disclosure?
 - c. What are consumer preferences regarding the method of disclosure (e.g., language used, placement)?
4. To identify the most expected and trusted sources to communicate about the appropriate use of post-harvest additives;
5. To investigate whether consumer awareness and knowledge about post-harvest additives, criteria for acceptance, disclosure needs and wants differ across countries.

3.1.1 Participants

Respondents in the five European countries (Netherlands, Germany, Belgium, Spain, France) were recruited via a European market research agency (MSI-ACI Europe BV). Inclusion criteria for participation were 18 years or older, fluent speaking/writing in the language(s) of the respective country, and being responsible for at least half of the grocery shopping in the household. Data was collected from approximately 1,000 respondents per country, samples being nationally representative in terms of age, gender, education level, household composition and urban-rural distribution. The full sample consisted of 5,035 respondents (50% male) with a mean age of 47.5 years, with 26% having a lower, 37% a middle and 37% a higher level of education. A quarter of the respondents were of single-person households without children and over 70% consisted of households of multiple persons (single or multiple adults with or without children). The majority of respondents (~60%) indicated to be responsible for all the grocery shopping in the household. Figure 1 shows the regional spread of survey respondents per country; sample demographics are summarized per country in Table 3 (note the small differences in frequency distributions of household composition and education level, which are due to the samples being nationally representative).



Source: © EuroGeographics for the administrative boundaries

Figure 1 *Panel A: European countries included in the survey. Panels B1-B5: regional spread of survey respondents per country. Darker shades indicate higher numbers of respondents.*

3.1.2 Survey design

In the first part of the survey, respondents answered a few questions about their food and F/V purchasing behaviour, and indicated how often they read information labels on fresh F/V. Next, four logos were shown on the screen, and respondents were asked to indicate which of these logos they had encountered before on fresh F/V, and what they thought the logos meant. The presented logos covered examples of a particular branded fruit variety, third-party certification schemes, and a branded post-harvest coating (Apeel). The logo from Apeel was included to assess familiarity with the company in an implicit manner (and potential effects of familiarity with the company on subsequent responses).



Table 3 *Demographic characteristics of survey respondents.*

	FULL SAMPLE	NL	DE	BE	ES	FR	Effect size*
Survey language		Dutch	German	Dutch 57% French 43%	Spanish	French	
Sample size <i>N respondents</i>	5,035	1,001	1,003	1,017	1,001	1,013	<i>ns</i>
Gender <i>N (%) respondents</i>							
Male	2,524 (50)	500 (50)	509 (51)	530 (52)	506 (51)	479 (47)	<i>ns</i>
Female	2,488 (49)	497 (50)	489 (49)	484 (48)	492 (49)	526 (52)	
Other/prefer not to say	23 (0)	4 (0)	5 (0)	3 (0)	3 (0)	8 (1)	
Age <i>M ± SD years</i>	47.5 ± 16.9	48.2 ± 17.2	47.9 ± 17.2	46.5 ± 16.8	46.9 ± 16.0	47.9 ± 17.2	<i>ns</i>
<i>Range</i>	18-85	18-84	18-85	18-84	18-85	18-82	
Education level <i>N (%) respondents</i>							
Low	1,295 (26)	185 (18)	330 (33)	228 (22)	207 (21)	345 (34)	<i>small</i>
Middle	1,868 (37)	364 (36)	459 (46)	361 (35)	416 (42)	268 (26)	
High	1,870 (37)	450 (45)	214 (21)	428 (42)	378 (38)	400 (39)	
Unknown	2 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
Household composition <i>N (%) respondents</i>							
Single person household, no children	1,221 (24)	263 (26)	302 (30)	259 (25)	138 (14)	259 (26)	<i>small</i>
Single-parent household with child(ren)	642 (13)	91 (9)	81 (8)	150 (15)	175 (17)	145 (14)	
Multi-person household, no children	1,646 (33)	383 (38)	358 (36)	311 (31)	293 (29)	301 (30)	
Multi-person household with child(ren)	1,448 (29)	254 (25)	255 (25)	276 (27)	370 (37)	293 (29)	
Other	78 (2)	10 (1)	7 (1)	21 (2)	25 (2)	15 (1)	
Responsibility for grocery purchases in the household <i>N (%) respondents</i>							
I do all of the grocery shopping	2,883 (57)	594 (59)	559 (56)	585 (58)	505 (50)	640 (63)	<i>negligible</i>
I do most of the grocery shopping	1,053 (21)	176 (18)	224 (22)	213 (21)	260 (26)	180 (18)	
I share in the grocery shopping responsibility	1,099 (22)	231 (23)	220 (22)	219 (22)	236 (24)	193 (19)	

*Effect size ω : >0.5= large; 0.3-0.5=medium; 0.1-0.3=small; <0.1=negligible. ns = not significant

The second part addressed consumer awareness and attitudes regarding the use of post-harvest food additives on fresh F/V. One of the key learnings from the focus groups was that consumer attitudes were highly sensitive to the amount of information provided about post-harvest additives. The interactive, two-hour discussions allowed for participants to deeply reflect on the topic and form a nuanced opinion, which cannot be mimicked in an online survey. Therefore, the impact of disclosure on consumer perception of post-harvest additives was investigated in a between-subjects design. To this end, respondents were randomly assigned to one of four balanced subgroups, each of which was presented with a different disclosure message (Table 3). Messages A and B were created to represent current European legislations regarding ingredient disclosure: Message A disclosed the presence of the additive using its corresponding E-number; in message B the ingredient names were used. Message C and D were created to represent alternative forms of disclosure: Message C described the protective function of the additive and the goal of its use (extended shelf life), together with a seal of approval from a generic European governing body (to communicate its guaranteed safe use). Message D was most detailed: besides referring to the protective function of the additive and the goal of its use, this message additionally described the plant-based origin of the post-harvest additive and the environmental benefits of its use (food waste reduction). This message was accompanied with a generic brand label (reflecting a hypothetical producer). Disclosure messages used in the between-subjects design are presented in Table 2.

Table 4 Food additive disclosure messages in the between-subjects design

Message A	Message B	Message C	Message D
<div> <div></div> <p>Treated with E-471</p> </div>	<div> <div></div> <p>Treated with mono- and diglycerides of fatty acids</p> </div>	<div> <div> Protective layer applied for longer shelf life  </div> </div>	<div>  <div> → Contains a protective layer made from plants → Stays fresh for longer → Reduces food waste </div> </div>

Respondents indicated whether they had ever encountered such a message on fresh F/V, and evaluated the message on several aspects (positiveness, clarity, usefulness, reliability, influence on purchase decision) on a 7-point Likert scale. Next, a detailed description of post-harvest additives was provided to all respondents (full disclosure):

'This message indicates that a protective layer has been applied to fruits/vegetables after harvesting to improve their shelf-life. This layer is made from edible, plant-based materials that occur in the peel, seeds and pulp of fruits and vegetables, and is completely color-, odor- and tasteless. The protective layer keeps moisture inside the produce and oxygen out, which slows the rate of spoilage of fresh produce. This way, the quality of fruits and vegetables is maintained longer, and the amount of food waste reduced.'

The full disclosure text was followed by several questions assessing consumers’ knowledge, attitudes, and disclosure wishes regarding the use of additives on fresh F/V. Next, the initial disclosure message was shown again, which respondents now evaluated in light of the full disclosure text (appropriateness, positiveness, clarity, usefulness, reliability, influence on purchase decision). After having answered the message-specific questions, respondents saw all four disclosure messages (A-D) simultaneously and indicated which message they preferred to disclose the use of post-harvest additives on fresh F/V. Next, participants were asked to select three (out of ten) statements they would include if they were to create their own disclosure message.

The remainder of the survey included questions on preferred disclosure channels, consumer trust, trusted sources of information regarding food and food safety, and food-conscious behaviour; these questions were identical for all respondents. All throughout the survey (except for disclosure message A), the terms ‘food additive’ and ‘E-number’ were deliberately avoided, because of the negative reactions these terms elicited in the focus group discussions (and the negative connotations reported in previous studies on food additives – see Introduction section). Using these notions in the survey questions could hence negatively bias consumers’ responses in all subgroups, and potentially overrule effects of the disclosure messages.

The questionnaire was created in Dutch and English simultaneously by the project team; the English version (provided in Annex 3) served as the basis for the German, French and Spanish translations. Questionnaires were translated by at least two native speakers from each language and double-checked by the project team. The survey was programmed by the research agency and distributed among respondent panels in the respective countries.

3.1.3 Analysis

Responses were summarized per country and (where relevant) per subgroups/disclosure message. For Likert ratings on a 7-point scale, differences between countries and subgroups were assessed with two-way ANOVAs including Subgroup (4 levels) and Country (5 levels) as factors; F-statistics, p-values and effect sizes (partial η_p^2) are reported. For categorical responses, differences between countries and subgroups were assessed using Chi-squared analyses; χ^2 -statistics, p-values and effect sizes (ω) are reported. Significant but negligible effects ($\eta_p^2 < 0.01$; $\omega < 0.1$) are not further discussed. For ease of interpretation, visualizations of Likert ratings show percentages of agree (5-6-7), disagree (1-2-3) and neutral (4) responses. All analyses and visualizations were performed in R version 4.0.5 (R core team, 2021).

3.2 Results

This section describes the key findings from the survey. A full overview of the results (including statistical details) is provided in Annex 4.

3.2.1 Awareness & knowledge about F/V information labels

In all countries, the majority of consumers (>60%) indicated to read information labels on fresh F/V less than regularly; this percentage was highest in the Netherlands (71%) (Annex 4, slide 5). From the four logos that were presented to respondents (Figure 2), logo A (branded apple variety) was recognized most often (by 70% of respondents). Among the logo recognizers, 57% interpreted it as indicating a product brand, and 25% as indicating a product variety (both of which are correct). The Fair Trade certification logo was recognized by about half of respondents overall (49%), but these percentages differed considerably across countries: more than half of respondents from the Netherlands (68%), Germany (69%), and Belgium (55%), but less than half of respondents from France (36%) and Spain (16%) recognized the logo. The majority of logo recognizers assigned it the correct meaning (fair trade), except for Spanish consumers, whose interpretations were distributed over all answer options provided. The EU organic certification logo was also recognized by about half of the respondents (52%), and was assigned the correct meaning by the majority of logo recognizers in all countries (36-53%) except for Spain (where the majority associated it with region of origin). The branded edible coating logo (Apeel) was recognized by least respondents (19%) overall, but more often by French (24%) and Spanish (28%) relative to Dutch (15%), German (18%) and Belgian respondents (12%). However, the percentage of logo recognizers assigning the correct meaning to the Apeel logo (i.e. extended shelf life) was very low in all countries (1-5%) (Annex 4, slides 6-11). Together, these findings illustrate that (a) European consumers generally pay little attention to the information communicated via labels on fresh F/V, and (b) even if F/V logos are recognized, their meanings are not always understood.

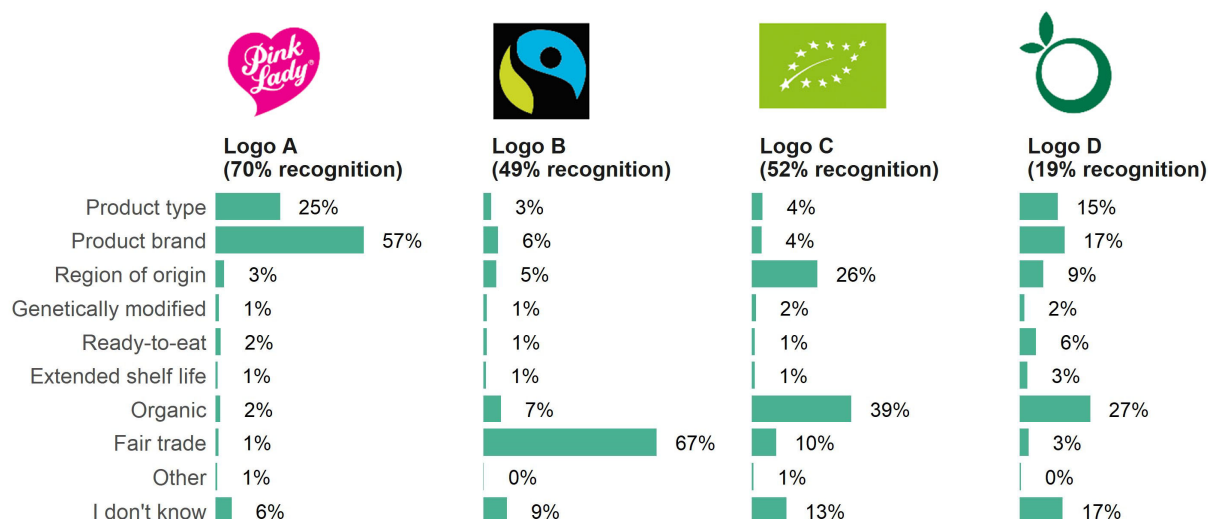


Figure 2 Frequency distribution of meanings assigned to the four logos by respondents who stated to recognize the logo.

3.2.2 Perceived value of benefits of post-harvest additives (before disclosure)

Product quality (taste, texture), shelf life, price, season and nutritional value were considered the most important aspects of fresh F/V in all countries (Figure 3, panel A), except for France (where region of origin was considered more important than nutritional value). Whether F/V are organically produced was considered least important, but still important to more than half of consumers in all countries (Annex 4, slides 13-14). From the nine potential F/V improvements proposed to respondents, all were considered (quite to extremely) desirable by the majority of respondents (>62%) in all countries (Figure 3, Panel B). Reducing food waste was most desirable in all countries (82-91% of respondents considering it desirable), closely followed by 'maintaining freshness' and 'less use of pesticides'. 71-85% of respondents found extended shelf-life of F/V a desirable improvement (Annex 4, slides 15-16). These results demonstrate that consumers highly value all of the benefits that post-harvest additives on fresh F/V can bring, irrespective of their knowledge about food additives.

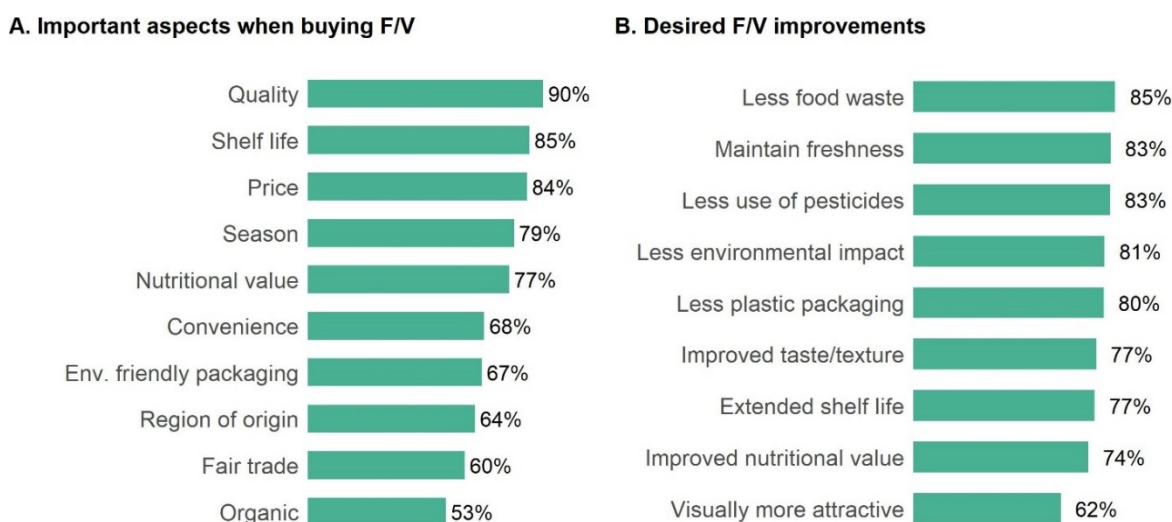


Figure 3 Panel A: Percentage of '[quite-extremely] important' responses per F/V aspect. Panel B: Percentages of '[quite-extremely] desirable' responses per F/V improvement.

3.2.3 Perception of additive disclosure messages

Message recognition (between-subjects)

When presented with an additive disclosure message (Message A-D; one message per subgroup), 16-22% of respondents indicated to have seen this message on fresh F/V before; the percentage of message recognizers was lowest in the Netherlands (10-14%) and highest in Spain (18-27%) (Figure 4). Disclosure messages that were created solely for the purpose of this research and thus non-existent (message C + D) were recognized as often as existing ingredient disclosure messages (message A and B). The majority of message recognizers did/could not specify on which produce they had seen the message (which was a required follow-up question), but those who did provide a specific answer predominantly mentioned 'apple' – which was the only produce that had (implicitly) occurred earlier in the survey (i.e. the Pink Lady and Apeel logo). Moreover, 'pear' and 'orange' were mentioned considerably more often by respondents who were presented with message D (which included an image of these produce) (Annex 4, slides 18-22). These specific responses likely reflect instances of priming (i.e. associations triggered by the prior survey content) rather than actual encounters with the disclosure messages.

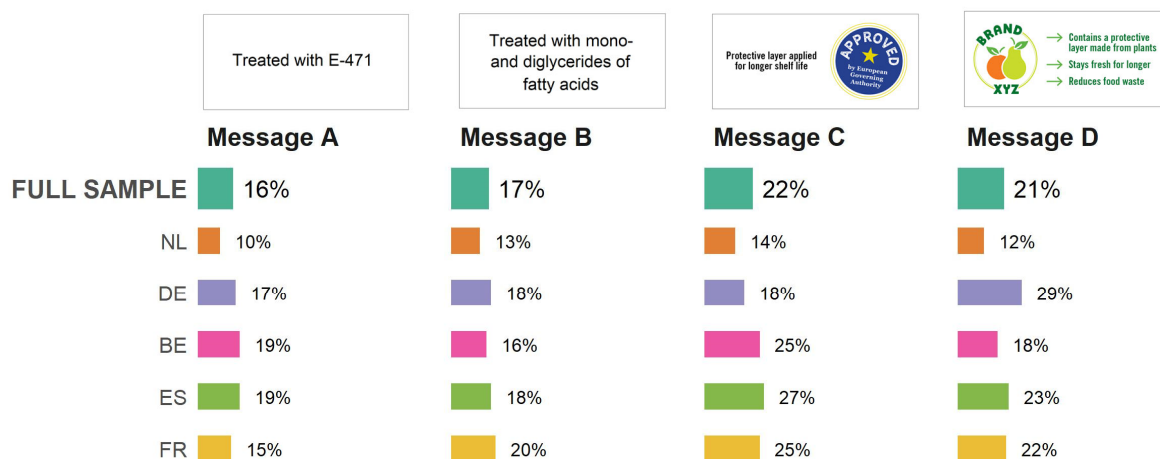


Figure 4 Percentage of consumers indicating to have seen the disclosure message on fresh F/V before.

Message evaluations before full disclosure (between-subjects)

As shown in Figure 5, the two ingredient disclosure messages (representing current EU legislations) were overall negatively perceived. Both message A and message B were evaluated as unclear by the majority of respondents (~60%), and the percentage of 'negative' responses was higher than the percentage of 'positive' responses. By contrast, the two alternative disclosure messages were overall positively perceived: over half of respondents evaluated message C as positive, clear, useful and reliable; for message D, percentages were even higher. These differences between messages were seen in all countries (Annex X, slide 24).

In all subgroups, most respondents agreed that the message would affect their F/V purchase decision ($\geq 49\%$), but correlation analyses suggest that the different messages affected purchase behaviour in different directions. In subgroup A, a negative relation was found between responses to the last and the first statement: respondents who indicated that message A would affect their F/V purchase decision most, evaluated this message as most negative (suggesting that ingredient disclosure may be a barrier for consumers to purchase fresh produce treated with post-harvest additives). By contrast, a positive association was found in subgroups C and D: respondents who indicated that message C/D would affect their F/V purchase decision most, evaluated these messages as most positive (suggesting that alternative disclosure messages may potentially drive consumers to purchase treated produce) (Annex 4, slide 25).

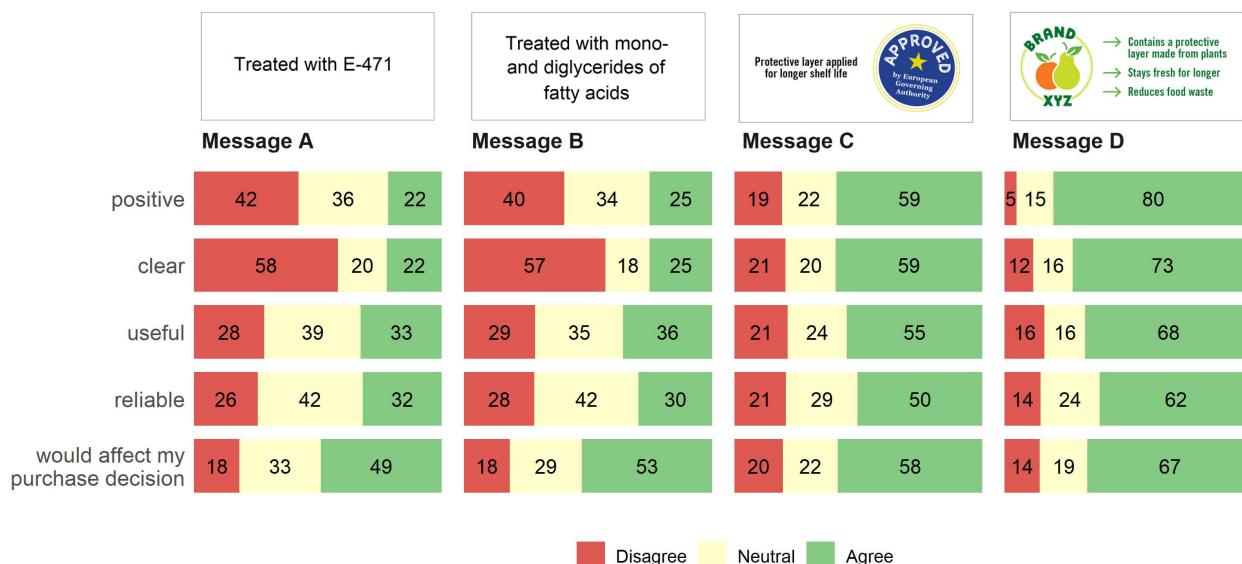


Figure 5 Evaluations of disclosure messages: percentages of 'agree' responses (green), 'neutral' responses (yellow) and 'disagree' responses (red) per statement and per message (subgroup).

Message evaluations after full disclosure (between-subjects)

After having read the full disclosure description, respondents were asked to re-evaluate the disclosure message they were initially presented with. As shown in Figure 6, the differences between messages were reduced when compared with initial evaluations (cf. Figure 5 above). Ingredient disclosure messages (A and B) were now positively evaluated by more than half of respondents, which implies that their initial negative evaluations were based on a lack of understanding or their initial negative response to E-numbers or ingredient names. The percentage of respondents who evaluated Message D as positive dropped from 80% before full disclosure to 70% after full disclosure. We believe this may relate to the fact that after having seen the most detailed disclosure message via message D, the full disclosure description was mostly repetitive/redundant. Having to evaluate the same disclosure message again without having learned anything new may have influenced their message perception in terms of positivity (but not in terms of clarity, usefulness or reliability). But even despite this small shift, Message D was still evaluated more positively than all other disclosure messages (Annex 4, slides 34-35).

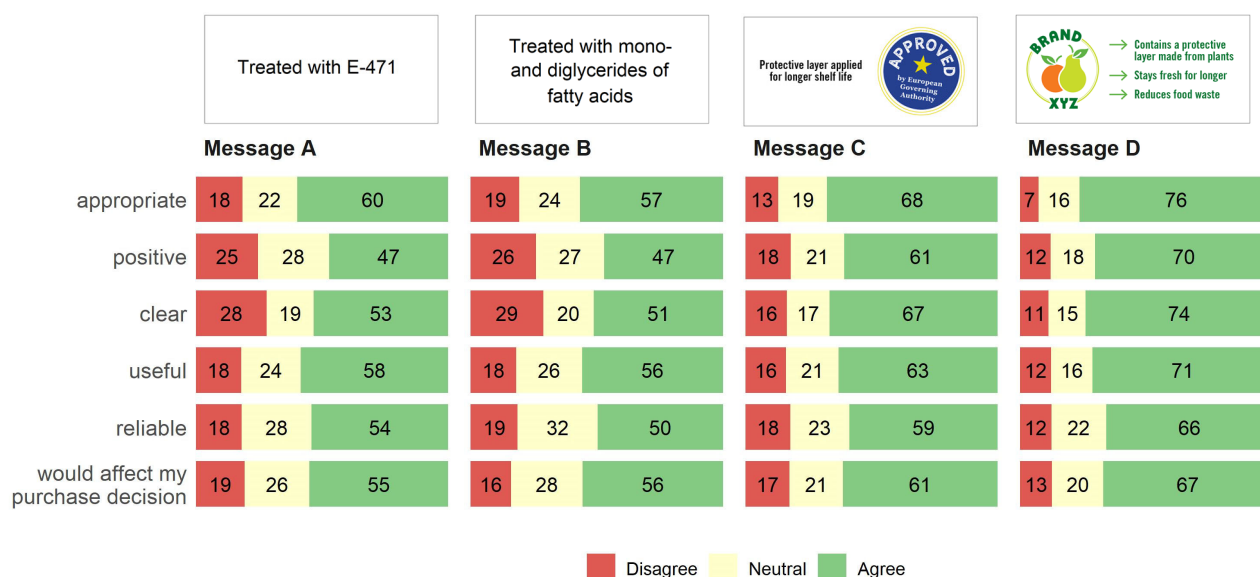


Figure 6 Evaluations of initial disclosure messages after full disclosure: percentages of 'agree' responses (green), 'neutral' responses (yellow) and 'disagree' responses (red) per statement and per message.

Preferred disclosure messages (within-subjects)

When prompted to choose between the four disclosure messages directly, respondents showed a clear preference for message D in all countries (thus confirming the between-subjects findings). Overall, 63% of respondents chose for message D, 24% preferred message C, and messages A and B were each chosen by 6% of respondents. The initial disclosure message induced a small response bias, such that respondents were slightly more likely to choose the disclosure message they were initially presented with, but this small priming effect did not alter the overall pattern (Annex 4, slides 36-37).

When asked to select three statements about post-harvest additives that respondents would definitely include if they were to create their own disclosure message, the statements 'keeps produce fresh for longer' (55%), 'edible' (47%), and 'made from plants' (43%) were selected most often. This top three was found in all countries and all subgroups. Ingredient statements (E-numbers, ingredient names) were selected least often (13 and 16%, respectively). A small effect of subgroup showed that respondents who were presented with an ingredient disclosure message initially (A/B) were slightly more likely to include this ingredient disclosure statement in their selection (Annex 4, slides 38-40).

Preferred disclosure scenarios and information sources

When presented with five scenarios showing how information about post-harvest additives could be communicated to consumers (Figure 7), respondents preferred an in-store sign (4) or brochure (5) over on-pack communication (1-3) in all countries. These two scenarios were considered attractive by 60-80% of the respondents and these ways of disclosure were least likely to be overlooked. As for on-pack communication, front-of-label information (1) was preferred over back-of-label information (2-3). Spanish and German consumers rated both back-of-label scenarios as equally attractive, whereas Dutch, Belgian and French consumers found a QR code less attractive than an ingredient list (Annex 4, slides 42-44).



Figure 7 Food additive disclosure scenarios.

Respondents were additionally asked to indicate which website or information source they (a) expected and (b) desired the QR code (scenario 3) to link to. Responses were roughly equally divided over all information sources proposed, with the Centre of Nutrition Communication (19%), the F/V supplier (17%) and I don't know (17%) as relatively most frequently expected sources, and the Nutrition Centre and a national governing body as most desired sources (both 23%). Expectations and desires regarding the information source varied somewhat between countries, but no specific expectation or preference was found in any country (Annex 4, slides 45-48). Also, respondents did not express an overwhelming interest in scanning the QR code. Overall, the percentage of respondents who indicated they would probably/definitely scan the QR code (44%) was somewhat higher than the percentage of respondents indicating they probably/definitely wouldn't (30%), except for the Netherlands, where more respondents indicated they wouldn't scan the QR code (48% vs. 28% who would) (Annex 4, slide 49).

Lastly, when asked which information source(s) respondents consulted in the past year to learn more about foods (multiple answers possible), the most frequent response was 'none' (36% of respondents). This percentage ranged from 26%-27% in Spain and Germany to 52% in the Netherlands, suggesting that Dutch consumers are least likely to consult any food information source. Two-third of respondents (67%) consulted at most one food information source in the past year, but none of the listed information sources was clearly preferred. Overall, the food supplier (21%), retailer (19%) and Centre for Nutrition communication (17%) were selected most often. Percentages differed somewhat between countries, but there was no clearly preferred source in any of the countries (Annex 4, slides 50-52).

3.2.4 Perceived likelihood of post-harvest additive use (after full disclosure)

After having read the full disclosure statement about post-harvest additives (introduced as 'protective layer'), the majority of respondents (59%) considered it likely that post-harvest additives are currently being used on fresh F/V; this percentage was relatively lowest in the Netherlands (48%), and highest in Spain (66%). A small effect of subgroup indicated that respondents who initially saw an ingredient disclosure message (subgroups A and B) found the current use of post-harvest additives on F/V slightly more likely than respondents who saw an alternative disclosure message (subgroups C and D) (Annex 4, slides 27-28).

3.2.5 Attitudes toward post-harvest additive use (after full disclosure)

The majority of respondents (60%) indicated to find the use of post-harvest additives ('protective layers') on fresh F/V positive and useful, and almost half (48%) to find their use environmentally friendly and safe. The percentage of respondents who found the use of post-harvest additives healthy, natural and common was somewhat lower, but still higher when compared with the percentage of respondents evaluating post-harvest additives as unhealthy, unnatural and uncommon. This pattern was similar in all countries (with overall more positive ratings in Spain). A spill-over effect of the initial disclosure message was again found, such that ingredient disclosure (messages A & B) negatively biased consumer attitudes toward post-harvest additive use; however, even in subgroups A and B, the use of post-harvest additives was perceived as positive and useful by over half of respondents (Annex 4, slides 29-31).

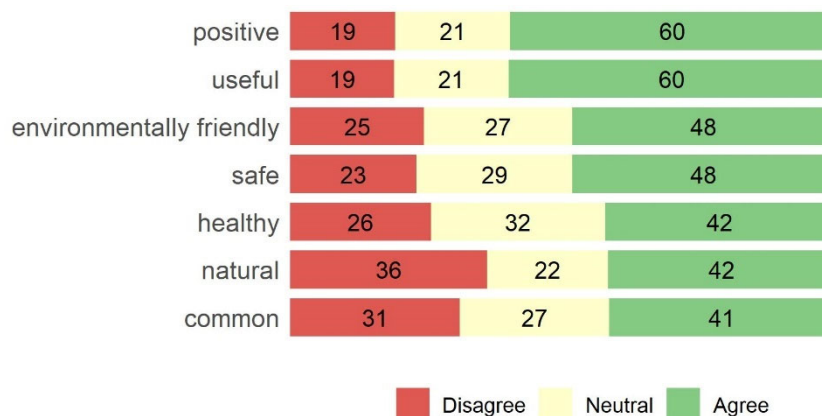


Figure 8 *Attitudes toward using a protective layer made of post-harvest additives on fresh F/V: percentages of 'agree' (green), 'neutral' (yellow) and 'disagree' (red) responses per statement.*

3.2.6 Additive disclosure wishes and needs

Consumers expressed a clear wish for transparency regarding the use of food additives on fresh F/V (Figure 9). Overall, 81% of respondents indicated they would want to know if the produce they purchased were treated with post-harvest additives, against 9% who would not; another 9% indicated not to care. The wish for disclosure was most pronounced in Spain (92%), and least pronounced in the Netherlands (69%), where a relatively high number of respondents (17%) indicated not to care. The wish for disclosure was not affected by the initial disclosure message (Annex 4, slides 32-33). When asked whether the use of food additives on fresh F/V should be disclosed to consumers if their safe use was approved by the EU, almost all respondents

answered this question with 'yes' (varying from 91% of respondents in the Netherlands to 99% of respondents in Spain) (Annex 4, slide 57).

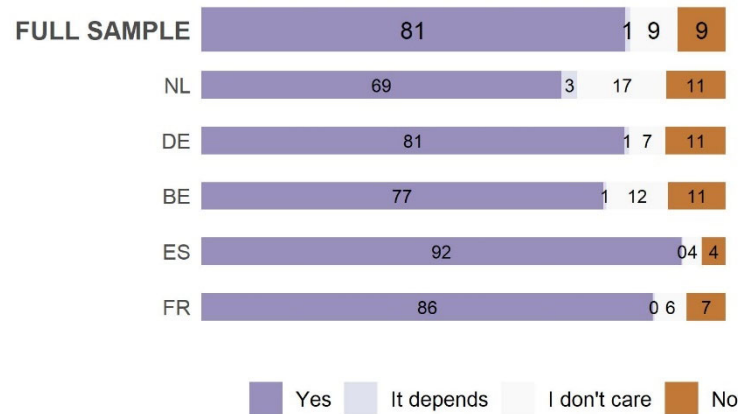


Figure 9 Consumer wishes for additive disclosure.

3.2.7 Consumer trust

The majority of respondents believed that foods sold in their home country as well as in Europe are safe to eat, and indicated to have trust in national and European governing bodies with respect to food safety. The majority of respondents also agreed with the statement that foods contain harmful substances, although this statement seems in contrast with the other statements. Consumer trust differed somewhat across countries: it was overall highest in Spain, followed by the Netherlands; French consumers expressed relatively least trust in food safety, especially regarding foods sold in supermarkets (Annex 4, slides 53-54).



Figure 10 Consumer food trust: percentages of 'agree' (green), 'neutral' (yellow) and 'disagree' (red) responses per statement

When asked to indicate their trust in various sources regarding food and food safety, consumer organizations, farmers and scientists were trusted by most respondents (~75%), whereas celebrities and influencers were distrusted by most respondents (50%). National and European authorities were trusted by >60% of respondents. Patterns were quite comparable across countries, but there were some small differences. For instance, in Spain, the percentage of respondents trusting European authorities (80%) was considerably higher than the percentage of respondents trusting national authorities (67%). In France, the percentage of respondents expressing trust in supermarkets and restaurants was relatively low (49%) when compared with other countries (in line with the previous question) (Annex 4, slides 55-56).

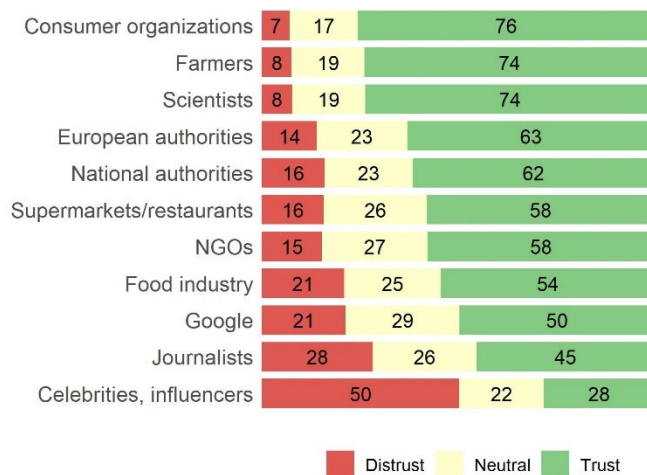


Figure 11 Consumer trust in information sources regarding food and food safety: percentages of 'trust (green), 'neutral' (yellow) and 'distrust' (red) responses per source.

Additional analysis (exploratory): Correlations with consumer trust

Exploratory Spearman correlation analyses were performed between consumer trust (scores averaged over the five statements above; first statement reverse-coded) and their awareness, attitudes and disclosure wishes regarding the use of post-harvest additives. A moderate positive relation was found between consumer trust and attitudes ($p=0.39$, $p<0.05$), such that consumers with higher trust were more positive (/less concerned) about the use of post-harvest additives on fresh F/V. Moreover, consumer trust was weakly positively related with the probability of scanning the QR code ($p=0.19$, $p<0.05$), which raises the possibility that the wish to learn more about food additives stems from curiosity rather than distrust. No evidence was found for a relation between consumer trust and disclosure wishes (Annex 4, slides 62-65).

4 Discussion

This research set out to investigate European consumers' awareness, knowledge and perceptions of post-harvest additive use on fresh fruits and vegetables, as well as their expectations, needs and preferences regarding disclosure. The main objectives were:

- To gain insight in European consumers' awareness, knowledge and perceptions with regard to the use of post-harvest additives on fresh fruit and vegetables.
- To investigate which conditions make post-harvest additive use on fresh produce acceptable or unacceptable for European consumers.
- To understand European consumers' needs and preferences regarding post-harvest additive disclosure.

To this end, six focus group sessions were executed among Dutch consumers, after which an online survey was conducted among consumers in five western European countries. The main findings are summarized in section 4.1; strengths and limitations are discussed in 4.2; implications and recommendations are provided in section 4.3.

4.1 Main findings

4.1.1 Awareness and knowledge

Findings from both studies showed that European consumers were largely unaware of the use of post-harvest additives and existing disclosure methods, which is in line with findings from previous consumer research on wax coatings (Bucher & Malcolm, 2022; Bucher et al., Submitted; Cliff et al., 2014). For most Dutch focus group participants, the focus group session was the first time they heard about post-harvest additives. From the discussions, it was clear that the production and handling of fresh F/V in general is not a top-of-mind topic. A few participants knew about wax coatings on citrus fruits and/or apples, which they mainly perceived to be for aesthetic reasons (shine, colour). Survey results showed that, when presented with existing ingredient disclosure statements, the vast majority of respondents (>80%) indicated to have never seen such statements on fresh F/V before. Also, the reliability of the 20% yes-responses was questioned for multiple reasons. First, the two (non-existing) alternative disclosure messages were recognized by a similar percentage of respondents. Second, when prompted to specify on which produce they had encountered the message, only few yes-responders could mention on which specific fruit or vegetable. Lastly, the three produce mentioned most often (apples, pear, oranges) were the only produce that were visualized in the questionnaire, which suggests a visual priming effect. We therefore interpreted these yes-responses as reflecting a more general affirmative response bias (as commonly found in survey research; Furnham, 1986) rather than actual knowledge about disclosure methods.

Despite a general lack of knowledge and awareness about post-harvest additives, the majority of European consumers found the current use of these additives on fresh produce not unlikely. Focus group participants were not surprised to hear that post-harvest additives are already being used, as they indicated they often do not get to see or know what actually happens to the foods they buy and eat. This reflects a more general impression about the food system that has also been noted in other studies (EIT Food, 2022; Wu, Zhang, van Klinken, Schrobback, & Muller, 2021).

4.1.2 Attitudes

Responses to the pre-disclosure questions in the survey demonstrated that, without being introduced to post-harvest additives, European consumers highly valued the potential benefits and outcomes that can be achieved through their use. The top three benefits consisted of reducing food waste, maintaining freshness and less use of pesticides (>83%); improving visual appearance was relatively least desirable, but still considered desirable by most consumers (62%).

Results from both the focus group discussions and the survey showed that the way in which post-harvest additives were introduced to consumers strongly influenced their perceptions. This corroborates the findings from prior studies on wax coatings (Bucher & Malcolm, 2022; Bucher et al., Submitted; Cliff et al., 2014). In the focus group sessions, information on F/V having received some 'treatment after harvest' without any further explanation was received with surprise, mistrust and uncertainty about what was exactly meant with this. The term 'treatment' elicited associations with pesticides, chemicals and unnatural processes. Subsequently, the terms 'additive', 'E-number' and 'coating' evoked negative associations with chemical and unnatural (processed) substances. Respondents felt this was in direct opposition with their general perception of fruits and vegetables (being fresh, natural, and unprocessed), making their combination implausible and unattractive. Only after being provided with a detailed disclosure statement about the use purpose, use benefits (sustainability), and plant-based/natural origin of an example post-harvest additive, attitudes switched from negative to positive – although some participants questioned the reliability of the source and the statement ('too good to be true').

A similar response pattern was seen in the survey, where information provision was manipulated between-subjects. Respondents who initially saw an ingredient disclosure statement, i.e., an E-number (group A) or ingredient name (group B), evaluated these statements as negative (only 20-25% thought it was positive and clear; only a third thought it was reliable and useful). By contrast, respondents who initially saw an alternative disclosure message, i.e., focusing on the use purpose of post-harvest additives combined with either a seal of approval from a European authority (group C) or their use benefits and plant-based origin (group D), evaluated this message as positive (50-80% found it positive, clear, useful and reliable). After having read a detailed description of the function, use purpose, benefits, edibility and plant-based origin of an example post-harvest additive (which was the same for all groups), ingredient disclosure messages were more positively evaluated. Also, the use of post-harvest additives on fresh F/V was considered positive and useful by the majority of respondents in all groups. However, a small difference between groups remained: groups who were initially presented with an ingredient disclose message (groups A and B) were not as positive as consumers who were initially presented with an alternative disclosure message (groups C and D).

Taken together, these findings suggest that European consumers are not against the use of any post-harvest additives on fresh F/V, provided that they are sufficiently informed about their use purpose and benefits, and reassured in terms of food safety (based on perceived naturalness). Without this knowledge, consumers rely on heuristics ('gut feelings') which lead to negatively biased perceptions of food additives (Bearth et al., 2014; Siegrist & Sütterlin, 2017). Although initially negative perceptions of ingredient disclosure messages became more positive when additional information was provided, the attested spill-over effect of ingredient disclosure on consumer attitudes toward post-harvest additives after full disclosure demonstrates how persistent such biased perceptions can be.

4.1.3 Disclosure needs and preferences

Findings showed a clear wish for transparency regarding post-harvest additive use among European consumers, which seems reflective of a more general, global trend (EIT Food, 2022; Nielsen IQ, 2021). Over 80% of survey respondents indicated they would want to know if post-harvest additives were used on the produce they purchase. An even higher percentage (95%) indicated that post-harvest additive use on fresh F/V should be disclosed to consumers, even if their safe use was approved by a European authority. The wish for disclosure was relatively lowest among Dutch survey respondents, which fits with the focus group results (where the need for disclosure was discussed in more detail). The Dutch focus group participants indicated that they did not want to be overloaded with information; also, many participants indicated to rather not be informed than to see an increase in the use of (plastic) packaging. Rather than disclosure via individual produce, participants preferred disclosure at a central place at the point of purchase. It was suggested to make detailed information about post-harvest additives available for those interested to learn more. When presented with five possible disclosure scenarios in the survey, respondents also preferred disclosure information to be presented at a central place at the point of purchase over on-pack communication on individual produce. In terms of content, disclosure messages focusing on the use purpose of post-harvest additives (either combined with their plant-based origin and environmental benefits, or with a European seal of approval) were preferred over ingredient and E-number statements. More specifically, when survey respondents were asked to choose which information messages they wanted used for disclosure, the use purpose statement 'keeps produce fresh

for longer' (which was included in Message C and D, albeit in slightly different words) was preferred most. This matches with the findings from Bearth et al. (2014) who suggested that providing reasons for using food additives may be beneficial for consumer acceptance. Respondents subsequently selected the statements 'edible', 'made from plants' and 'reduces food waste', respectively (all of which were used in message D). 'Approved by the EU' (which was used in message C) was selected less often, but was still preferred over ingredient statements.

Despite the strong wish for transparency, however, findings also suggest that European consumers take little effort in learning more about post-harvest additives, and that the production and handling of fresh produce in general is not a top-of-mind topic. Survey results showed that reading F/V ingredient labels is not common practice for the majority of European consumers, and existing ingredient disclosure messages were hardly recognized. Focus group participants found it too much of a hassle to check the information labels on every single product they purchase, indicating they had more important things to worry about. In several focus group discussions, the suggestion was raised to provide a possibility to look up more information about post-harvest additives for those interested, for instance by means of a QR code. When this option was presented to survey respondents, however, less than half expressed the intention to do so. Also, no specific expectation or desire was found regarding the source providing this information, but the (national) Centre for Nutrition Communication and a national governing body were selected most often. Results moreover suggest that looking up information about foods in general is not common practice among European consumers. Over a third of respondents indicated not to have consulted any food information source in the past year; over two-thirds consulted one information source at most. The limited interest in learning more about post-harvest additives (and foods in general) may relate to the findings on consumer trust. The majority of respondents believed that foods sold in Europe are safe to eat, and expressed trust in national and European food safety regulations (despite general feelings of suspicion regarding the current food system). Also, trust in many food information sources was high, with consumer organizations, farmers and scientists being trusted most. This high level of trust possibly takes away the urge to educate oneself about foods and ingredients; however, it does not seem to take away the need for transparency. This need for transparency despite a high level of trust was also present in a Citizens Participation Forum with participants from 13 European countries (EIT Food, 2022).

4.1.4 Country differences

Differences in survey responses across countries were small, and were found to be survey-wide rather than question-specific. Specifically, Spanish consumers provided overall most positive and most affirmative responses (i.e. they displayed the strongest agreement bias), whereas Dutch consumers were least inclined to provide socially desirable responses (i.e. they most often answered 'I don't know' and 'I don't care'). These response biases seem to reflect two contrasting cultural communication styles, i.e. that of a higher-context culture (preferring indirect, implicit communication) and a lower-context culture (preferring explicit, direct communication) (Hall, 1976; Hall & Hall, 1990). Regardless of these general cultural differences, differences in evaluations of post-harvest additive disclosure messages were similar in all countries, confirming an overall preference for alternative disclosure messages (focusing on their use purpose and plant-based origin) over ingredient statements. Moreover, consumers in all countries expressed a clear wish for transparency regarding post-harvest additive use.

4.2 Strengths and limitations

To our knowledge, this is the first study investigating consumer perceptions of post-harvest additives beyond wax coatings on apples, hence gaining novel insights in this domain. A strength of the current study is the combination of qualitative and quantitative research methods. The focus group discussions gave initial insights from Dutch consumers about the topic. The online survey tested and quantified these findings in a larger international sample, and further extended the findings by incorporating the perspectives and ideas gained from the focus groups in the survey questions.

Another strength is the careful way in which the topic of post-harvest additives (which appeared not top-of-mind in consumers) was approached. Prior to introducing post-harvest additives, both the focus groups discussions and the survey started with general questions about F/V purchase and consumption behaviour. Also, concrete examples of (existing disclosure methods on) fresh produce as typically sold in supermarkets were used to make the topic more concrete and ensure active participation. Moreover, the notion 'additive' (which elicited strongly negative reactions in focus group participants) was deliberately avoided in the survey, to avoid a negative response bias based on (non-experimentally manipulated) terminology. E-numbers also elicited negative reactions, but an example of an E-number was presented in the survey as part of our experimental design, precisely to demonstrate this response bias: we showed that using an E-number in a post-harvest additive disclosure message negatively affects consumer perceptions of post-harvest additives. We believe that this careful approach has led to valuable findings that may not have been found if the topic was addressed more directly.

Response bias is known to be prevalent in survey research (Furnham, 1986), which we took into consideration when designing the survey and interpreting the results. For instance, several binary choice questions (e.g. 'have you encountered this logo / this message before?') were followed by a multiple choice or open question asking respondents to elaborate on their response (e.g. 'what do you think this logo means?'; 'on which produce did you see this message?'). By including these follow-up questions, we were able to distinguish actual recognition from (subconscious) priming effects and/or socially desirable response behaviours. Moreover, responses to the survey questions were interpreted against the focus group results, where topics were discussed in more detail and participants were stimulated to reflect on their own responses. Although survey respondents were very clear that transparency and disclosure regarding post-harvest additive use was essential, many focus group participants indicated they had never thought about it before, and admitted that they would probably no longer think of post-harvest additives a month later (as they have more important things to worry about). This nuanced our interpretation of survey responses, as it raises the question whether consumers will actually pay attention to post-harvest disclosure information when this information is provided.

Every research also has limitations that need to be considered when interpreting the findings. First of all, the example post-harvest additive used in our study was described as a plant-based, edible protective layer. As this definition does not apply to all post-harvest additives, it limits the generalizability of our findings. Specifically, 'plant-based' implies naturalness, which is known to be highly important for consumers (Bearth et al., 2014; Román, Sánchez-Siles, & Siegrist, 2017). Indeed, 'made from plants' and 'edible' were in the top three of preferred post-harvest additive disclosure statements, highlighting the importance of these properties for respondents. Prior research has indicated that not all types of food additives are equally known or appreciated (German Federal Institute for Risk Assessment (BfR), 2021). Moreover, different additives have different use purposes and bring different benefits: whereas some additives may offer personal benefits for consumers, others may be more beneficial for the manufacturer than for the consumer, which may result in different evaluations (Bearth et al., 2014). Based on our current findings, we cannot tell whether the use of post-harvest additives without these attributes would be equally acceptable to consumers.

Second, our study focused on consumers from Western-European countries, whose perceptions and needs may differ from consumers in other countries and/or continents (Wu et al., 2021). For instance, food safety may not be a genuine concern for Western European consumers, but could play a much bigger role for consumers in other countries. Also, extending the shelf-life of perishable produce may be much more important to consumers from countries where foods are not as readily available.

Third, the four post-harvest additive disclosure messages that were created and tested in the survey differed not only in linguistic content, but also in other (visual) characteristics. As a result, we cannot exclude the possibility that the use of colours and pictures contributed to the more positive evaluations of alternative disclosure messages relative to the ingredient disclosure messages (which were printed in black on a white background to mimic their typical appearance on ingredient lists). This being said, respondents' preference for the two alternative disclosure messages aligned with their preferences for statements to include in a post-harvest additive disclosure message: all statements that were used in the alternative disclosure messages were selected more often than the ingredient and E-number statements, which strongly suggests that the preference for alternative disclosure messages were not exclusively due to the colours and pictures. The finding that the use purpose statement 'keeps produce fresh for longer' was most often selected, likely explains the

preference for messages C and D (both of which included this statement) over messages A and B (in which this statement was excluded). Still, it is possible that this preference could also be based on the absence of ingredient statements. The linguistic content of the alternative disclosure messages also differed in more than one respect. The statements 'edible', 'made from plants' and 'reduces food waste', which were used in message D but not in C, were all preferred over the European approval statement, which was used in message C but not in D. As a result, we cannot determine which particular statement(s) determined the preference for message D over message C.

Lastly, despite the overall positive attitude towards post-harvest additive use on fresh F/V, consumers may still prefer untreated over treated produce when given the choice. Such a question was not included in the survey, but the focus group results did point in this direction: participants indicated they wanted fresh F/V to be as natural as possible (while also admitting that this was probably not realistic). Similarly, a study among Canadian consumers showed that many preferred unwaxed over waxed apples even after being informed about the use purpose and benefits of the wax coating (Cliff et al., 2014). Note, however, that such reflective preferences may not translate to actual purchase or consumption behaviour. One may wonder whether a (romanticized) desire for natural and unprocessed foods is strong enough to prevent consumers from purchasing treated produce, given their overall low involvement with the topic, and all other factors influencing food choice and consumption behaviour (such as time, convenience, price and availability).

4.3 Implications and recommendations

Findings showed that European consumers are positive about the use of post-harvest additives on fresh F/V, as long as their use purpose, environmental benefits and (plant-based) origin are known. At the same time, consumers know too little about food additives to extract this information from an ingredient name or E-number, and they lack the time and motivation to educate themselves in this respect (Bearth et al., 2014). These findings have important implications for European policy makers as well as for companies and organizations striving for consumer transparency.

In the EU, food additives may only be added to foods if they are thoroughly tested. Once approved, food additives receive an E-number, which has to be declared in the ingredient list of commercial food products. Although this system of E-numbers was put in place to empower consumers in making informed food choices, our results showed that E-numbers were perceived as unclear and negatively biased perceptions of post-harvest additives even after having received detailed information about their use purpose, environmental benefits and origin. These findings call into question the effectiveness of current EU legislations regarding ingredient disclosure. In addition, consumers find transparency regarding post-harvest additive use on fresh F/V essential, but this need for transparency is not always met as ingredient lists are not mandatory for all commercially sold F/V (GS1 in Europe, 2016). At the same time, consumers know too little about food additives to extract this information from an ingredient or E-number statement, and are unlikely to take effort in learning more about the foods and ingredients they purchase and consume. These contradictory findings pose a challenge for companies and organizations that strive for transparency, as consumers may never read the information they ask for. Future research investigating the effects of disclosure on consumer awareness, attention and corresponding F/V purchase behaviour in more real-life settings could provide valuable insights in this respect.

Post-harvest additive disclosure seems essential to meet consumers' need for transparency. At the same time, disclosure information should not be exhaustive to avoid information overload (Di Pasquale et al., 2014; Mancini, Marchini, & Simeone, 2017). Although ingredient and E-number statements are a highly compact disclosure method, a declaration in an ingredient list alone is not recommended when considering consumers' limited knowledge about food additives and their negative associations with E-numbers. It is advised to make explicit why post-harvest additives are used, i.e. extending the shelf-life of perishable produce (see Bearth et al., 2014 for a similar suggestion), which can be linked to their environmental benefits (as food waste reduction is highly valued by European consumers). In the case of plant-based additives, mentioning their origin seems beneficial considering the general desire for natural foods (Román et al., 2017) and negative perceptions of synthetic substances (Siegrist & Sütterlin, 2017). Communicating explicitly that post-harvest additives are safe for consumption may not be crucial, given consumers' trust in European food safety regulations. However, if

parties wish to include food safety in their disclosure message, it is advised not to do this via the existing European labelling system: E-numbers raise suspicion rather than trust, which may lead to a reduced or even reversed intention to buy labeled products (Rousseau, 2015). By contrast, trusted certification labels can increase the intention to buy labeled products (Beldad & Hegner, 2020; De Canio, Martinelli, & Endrighi, 2021). Prior research has shown that consumers prefer independent organizations over retailers or governing bodies as certification institutions (Sporleder, Kayser, Friedrich, & Theuvsen, 2014; Wu et al., 2021). In our study, European consumers displayed high trust in consumer-oriented organizations. Possibly, collaborations with such parties could be helpful in communication about post-harvest additives (and food additives more generally).

Lastly, we found that consumers' perceptions of post-harvest additives improved with information provision. Also, they preferred information to be presented at a central place at the point of purchase over on-pack communication on individual produce. However, in-store education of consumers during their daily shopping routines may not be successful given consumers' lack of time and motivation to learn more about foods and ingredients, and it may not be practical given the size and scale of a typical grocery retail location. Therefore, it is worthwhile to investigate the effectiveness of in-store communication and to explore effects of alternative disclosure channels in future research. Another possibility to increase consumer knowledge and awareness would be to start educating them earlier in life, i.e. by teaching children (the 'consumers of the future') about the food system – and the reasons for using food additives – in schools. However, further research is needed to investigate the effectiveness of such a strategy.

5 Conclusions

With this research, we have shown that European consumers have hardly any knowledge about post-harvest additives, and are unaware of current disclosure methods. Perceptions of post-harvest additives are generally positive, once consumers are informed about their use purpose, environmental benefits and (plant-based) origin. In order to satisfy consumers in their need for transparency, while also taking into account their limited knowledge of additives and the lack of time and motivation to educate themselves in this respect, it is recommended:

- to always disclose the use of post-harvest additives;
- to use concise information focusing on the use purpose of post-harvest additives rather than mere ingredient or E-number declarations;
- not to present this information on individual products but to explore alternative disclosure strategies.

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Annex 1 Ethical clearance

6706 kn Hollandseweg 1 Wageningen | The Netherlands

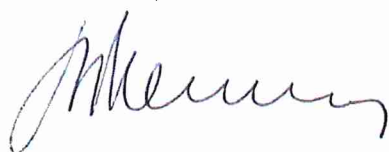
To whom it may concern

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

Title: Consumers' knowledge, perceptions and acceptance of post-harvest additives on fresh produce and preferred disclosure methods
Project team: Gertrude Zeinstra, Geertje van Bergen
Funding: Apeel Sciences
Period: 2021 – 2022
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.

With kind regards,



Professor Dr Marcel Verweij
Chair Social Sciences Ethics Committee

DATE
23-09-2021

SUBJECT
Ethical approval of research project

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Annex 2 Full report results focus group discussions

RESULTS QUALITATIVE RESEARCH

Consumer perception on Post Harvest Additives

Wageningen UR Food & Biobased Research



November 2021
Attn: Geertje van Bergen / Gertrude Zeinstra

1

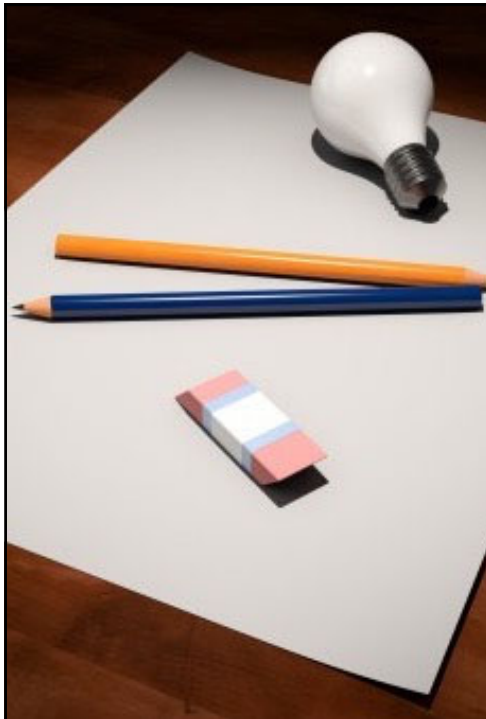
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Objective

- The aim of the research is to explore consumers' awareness, knowledge, perceptions and wishes regarding the application of post-harvest additives on fresh fruits and vegetables.
- Key Research Questions are
 - What do consumers know about post-harvest additives on fresh produce?
 - Are they aware that additives are used on fresh produce (i.e., do consumers expect additives to be applied to conventional produce)?
 - Do they perceive different categories of additives that may be applied to fresh produce?
 - What do they think about these (different categories of) additives?
 - Do they consciously or unconsciously buy fresh produce with these additives?
 - Which factors influence consumers' acceptance of additives, such as risk perception, benefit perception, trust, their knowledge of processes and regulations, product type including habitual packaging.
 - Which criteria/ aspects make the use of additives on fresh produce acceptable or unacceptable?
 - How do consumers want to be informed about safe post-harvest additives on fresh produce?

2

2

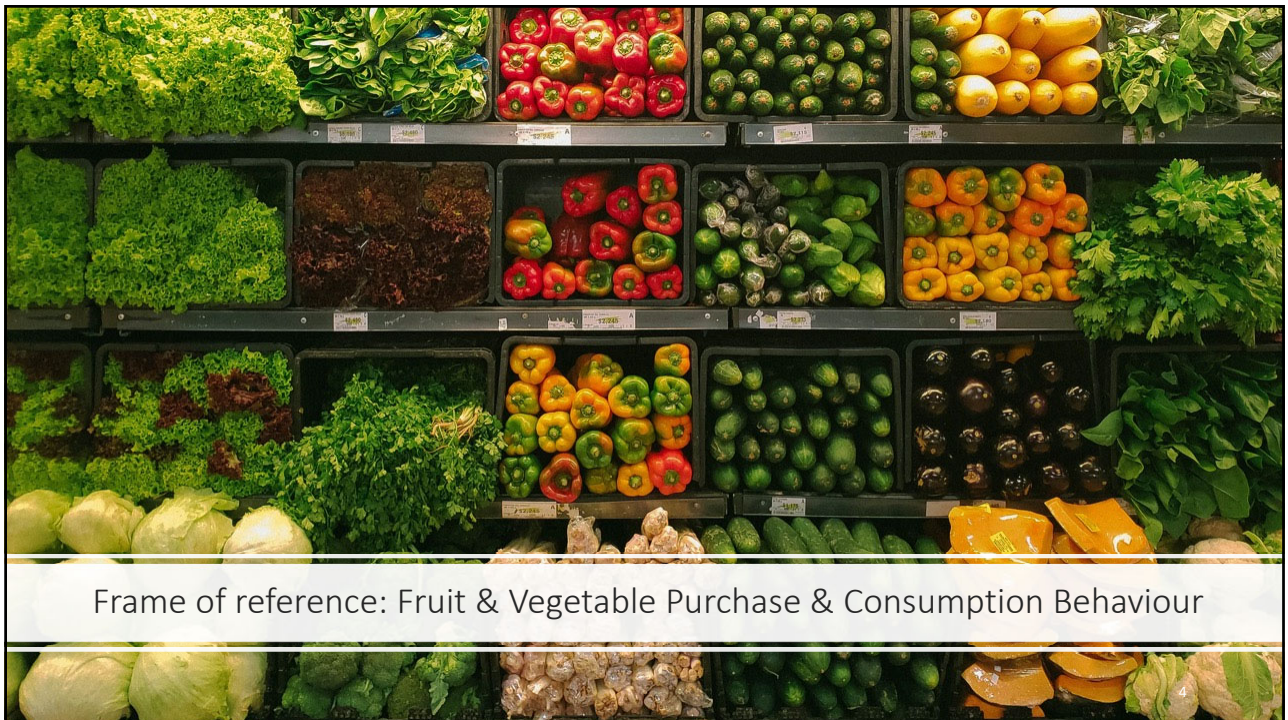


Set Up

- 6 group discussions with 5-6 respondents each
 - 3 groups with consumers who are relatively high food-conscious
 - 1 group 18-35 years
 - 1 group 35-50 years
 - 1 group 50-65 years
 - 3 groups with consumers who are relatively low food-conscious
 - 1 group 18-35 years
 - 1 group 35-50 years
 - 1 group 50-65 years
- All participants are responsible for at least 50% of their weekly shopping, and buy fresh fruit and vegetables on a regular basis
- Within each group:
 - at least 2 men
 - spread across level of education MBO-HBO-University
 - some geographical spread
- Each group lasted 2 hours.
- Research conducted: October 2021, online.

3

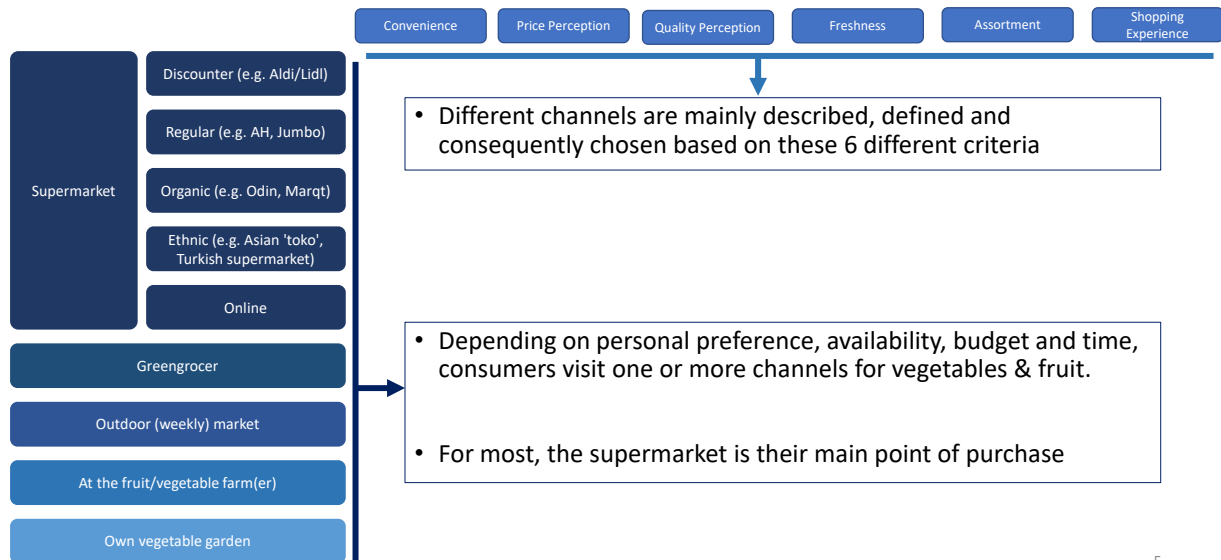
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Frame of reference: Fruit & Vegetable Purchase & Consumption Behaviour

4

Fruit & vegetables are bought at many locations, which are perceived differently on different aspects



5

Each location has specific drivers or barriers

		Convenience	Price Perception	Quality Perception	Freshness	Assortment	Shopping Experience
Supermarket	Discounter (e.g. Aldi/Lidl)	• Long opening hours • Proximity to home • one-stop-shopping	• cheap(er)	• varies • Lidl highly valued	• varies • Lidl highly valued	• normal range	• nothing special • just grocery shopping
	Regular (e.g. AH, Jumbo)		• average to expensive	• good	• depends on product • can vary	• normal range	• nicely laye- out • mist spray
	Organic (e.g. Odin, Marqt)	• proximity • often only in bigger cities	• expensive	• high • natural	• sense of purity	• specific	• natural, rustique look&feel
	Ethnic (e.g. Asian 'toko', Turkish supermarket)		• cheap(er)	• good	• sense of purity	• specific/exotic	• new products • fun kind of trip
	Online	• no personal effort required	• more expensive	• first-timers often hesitant	• less controllable • can't select actual item	• specific/exotic	• fast but very functional
Greengrocer		• additional trip	• more expensive	• specialist / expert	• high	• broad	• personal engagement • 'small talk'
Outdoor (weekly) market		• additional trip • only fixed days	• cheap(er)	• often easily perishable	• seen as already ripe • not chilled	• broad	• fun experience • depending on weather/season
At the fruit/vegetable farm(er)		• additional trip • distant	• cheap(er)	• craftsmanship • thus good quality	• direct from the ground/tree	• often few types of products	• fun experience • 'field-trip'
Own vegetable garden		• within reach • labour&time intensive	• for 'free'	• depends on skills & circumstances	• direct from the ground/tree	• depends on season, size and harvest	• dedication, pride & involvement

6



Shopping for produce

- 'I buy from 3 supermarkets, and the fruit and vegetables are really the best at Lidl. Good quality/price ratio and you can store it for a long time.' (low, 18-35)
- 'I have to throw away things from the market more quickly because I often buy too much there and the quality is also less.' (low, 18-35)
- 'It's not proven that organic is healthier per se. It could be better for the environment, but that has not been proven either. It is much more expensive, so that's why I don't buy it. And it doesn't make any difference in terms of taste.' (low 50-65)
- 'The organic produce looks less attractive, more unnatural. The organic ones have a different shape. Carrots for instance are still covered with sand.' (low, 50-65)
- 'I love to go to toko's (ethnic shops) but it takes more time and then I just go to the Albert Heijn, which feels much more standard.' (high 18-35)
- 'On the market you usually have to consume it quicker because it stains and goes bad much more quickly.' (high, 18-35)
- 'I do try to buy local, I like that it doesn't have to be transported from far away. I like to support the local farmer and it's better for the environment.' (high, 35-50)

7

7

Purchase & handling behaviour varies between fruit and vegetables



Fruit

- Often bought without fixed consumption moment in mind.
- Bought in larger quantities, for multiple days.
- Certain favourites always at home (e.g. apples, bananas), other types bought more infrequently, based on: desire, promotion, season.
- Put in bowl, ambient: looks nice and inviting to eat.
- Intrinsically convenient: often easy to eat at any time, at any place. Fast to eat (at most needs to be peeled).



Vegetables

- Often bought with a fixed meal in mind.
- Bought in the quantity that the recipe/meal requires.
- More variation, with some 'core products', such as onions and bell peppers. Seasonality, promotion and personal desire are often leading purchase decisions.
- Put in fridge; no or little decorative value.
- Intrinsically less convenient: needs to be peeled, cut, sliced or diced and then cooked. Convenience is gained by buying pre-sliced/cut vegetables in a bag.

As a result of this behaviour and usage, most consumers acknowledge that fruit is more prone to turn bad and to be thrown out than vegetables.

8

8



consumer
quotes

Purchase & handling behaviour varies between fruit and vegetables

- *'Vegetables are not kept as long as fruit. You buy it for a specific meal and then it's gone.'* (low, 50-65)
- *'I have more fruit than vegetables at home. And vegetables are easy to freeze.'* (low, 50-65)
- *'Bananas I often buy a little too green and with kiwis I feel to see which one is still hard and firm.'* (high, 18-35)
- *'A pear or an avocado ripens for a while, so they remain longer and you can buy more. Things I want to eat tomorrow, I buy just the right amount.'* (high, 50-65)

9

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Throwing out fruit&vegetables hurts, but not as much to everyone.

- Throwing away fruit and/or vegetables is ideally prevented. There are different mechanisms to avoid food waste:
 - Buying less quantities – better matching expected consumption with the amount purchased
 - Freeze products for later use
 - Use it in blended food types, where looks of the produce is no longer relevant: smoothies or soups
- All share the sentiment that food should not go to waste, but some feel more conflicted than others. The intensity of this feeling depends mainly on the following criteria:
 - Budgetary reasons: they paid for it, so wasting produce is throwing away money, especially if it was an expensive product and budget is tight.
 - Food appeal reasons: some really want their fruit&vegetables to look spotless, otherwise it diminishes their desire to eat it and the risk of being thrown out increases.
 - Sustainability reasons: the level of involvement in the broader societal theme of food waste and sustainability influences the level of ease/difficulty to throw food away.

10

10



consumer quotes

Throwing out fruit&vegetables hurts, but not as much to everyone.

- 'If bananas start turn brown I find them not appealing anymore, so I throw them away.' (low, 18-35)
- 'I sometimes throw fruit away, simply because I forget I had it at home.' (low, 18-35)
- 'Throwing things away is for me mainly about wasting my money, I think vegetables are generally very expensive so I don't want to throw them away.' (low 18-35)
- 'Sometimes you can only buy a larger quantity than you need for a recipe and you won't be using the rest. I throw that away, but it doesn't feel okay.' (low, 18-35)
- 'Throwing it away is a waste of the product and a waste of my money.' (low, 50-65)
- 'I buy quite a lot of fruit and vegetables in large quantities. And sometimes plans change and we don't eat them at home and I don't eat them any more. Then I recycle them as fertiliser for my own vegetable garden at home.' (high, 50-65)
- 'I used to work with menus so that I planned my purchases, almost nothing gets thrown away.' (high, 50-65)

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Awareness & Knowledge of Post Harvest Additives

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Participants were shown the following stimulus and asked to tell what they see and notice.



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13

First responses relate to the following topics

Type, usage frequency
& familiarity with the
specific fruit/vegetable

- Most products are known and used frequently
- For quite a few, the Pakistani mango is an unfamiliar product

Packaged vs
Unpackaged items

- Packaging, in particular plastics evokes a lot of spontaneous reactions

Single items vs
Multiple Items

- Some items come in too large quantities (e.g. lemons and chili peppers).

Labels/Stickers as
indicator for brand,
quality, organic
product or type
recognition

- Labels and stickers are mainly seen as:
- a way to define the sort/brand (as a help for the cashier)
- A quality mark for organic/fair trade

The aspect of post-harvest additives/treatment is not mentioned spontaneously.
For most participants, this topic is not top-of-mind, nor known.

14

14



When discussed, reasons (expectations) for treating produce in general are twofold

- Aesthetics: to make the fruit/vegetable look appealing: shiny, nice colour, no spots
 - wax on apples
 - dying/spray-painting of citrus fruits to make the colour better
 - mist spraying at the super market
- Sustainability: to keep it longer fresh
 - harvest before they're ripe
 - cool/chill them (cold water, refrigerated area/transport)
 - wrap in plastic

15

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The role of plastic packaging is ambiguous

- Plastic packaging as a topic evokes negative connotations among the majority: plastics are bad for the environment and are seen as redundant for some products.
- The rationale for a plastic packaging is not known to everyone. A number of reasons are mentioned:
 - to protect the product from damaging too easily during transport
 - to make it more hygienic; protection against hands of others shoppers.
- Only very occasionally there appears to be awareness that plastic can keep a product longer fresh.

16

16



consumer
quotes

Role of plastic ambiguous and not always clear.

- 'With the 3 bell peppers, the packaging makes sense, otherwise everyone would only buy the red ones.' (low, 18-35)
- 'Grapes and berries could easily be sold in a cardboard box or a paper bag as well. The plastic is not necessary.' (low, 18-35)
- 'It's quite funny that the cucumber is in plastic and the eggplant or zucchini isn't. You can eat the skin of all three.' (low, 35-50)
- 'Cucumbers in plastic really drives me crazy. It's completely useless.' (high, 35-50)
- 'Maybe it makes the product less easily perishable, but that doesn't weigh up to the plastic. Plastic stays forever.' (high, 35-50)
- 'I see a lot of plastic, can't they reduce that a bit?' (high, 50-65)
- 'The plastic protects the cucumber from drying out.' (high, 50-65)

17

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Stickers: recognition & branding, but perceived as quite superfluous

- Stickers are described to have several functions:
 - a help for cashiers to recognise the type of fruit/vegetable.
 - to distinguish the brand sign (e.g. a Chiquita banana vs another brand)
 - to indicate a specific aspect/process: fair trade, organic
- Although they may be useful in some cases (e.g. recognition of type of apples), most consumers do not consider this a personal added value.
- There's a tendency to consider stickers annoying: need to be peeled off, leave a spot with glue that needs to be cleaned.
- The function of indicating a post-harvest treatment is widely unknown (mainly because most are also not aware of this process to begin with).

18

18

consumer quotes

Stickers: type/brand, organic, fairtrade

- 'It think a Fairtrade sticker like on the bananas can trigger. If they're on promotion, I would buy these.' (low 18-35).
- 'Those stickers indicate if it's Fairtrade or organic.' (low 35-50)
- 'Those stickers are annoying, sometimes you don't see them and you might take a bite in them when eating your apple.' (low, 30-50)
- 'I don't really pay attention to those organic stickers. You never can be sure that it's truly organic anyway. As a consumer, it's hard to find out.' (low, 50-65)
- 'They're unnecessary to put on a natural product. I mean, you can see what it is right?' (low, 50-65)
- 'The sticker is for the cashier, to know which type/brand it is. But for me, they're not necessary.' (high, 35-50)
- 'It's unpleasant to have all those stickers. The glue makes it yucky.' (high, 18-35)
- 'I don't think that it's necessary to sticker each apple. One in ten would be enough.' (high, 18-35)
- 'Those stupid stickers, they're annoying when washing your fruit.' (high, 35-50)
- 'It's easy for the cashier, but I hate it when they are on my apples.' (high, 50-65)
- 'There are different kinds of kiwis, so the sticker indicates which type or brand it is.' (high, 50-65)
- 'There are a lot of quality marks, organic, fair trade.' (high, 50-65)

19

19

Label is for barcode and quantity

- Labels (on a net of citrus fruit) is mainly seen as a means to carry the barcode for scanning at the checkout point.
- Some mention it can be to indicate the total weight or number of items.
- Most respondents have never paid any further attention to the information on such a label:
 - they contain natural products, so there's not an obvious reason or need to check the 'ingredient list'. After all, what you see is what you get.
- Some are aware that fruits are sometimes waxed to make them look more shiny or colourful.
- They have the knowledge that when you grate a (non-organic) lemon you need to clean it very thoroughly to get rid of the wax layer. But the label as such is for the majority not intuitively considered to be a source to find more input about this.
- Only very few (high food conscious consumers) have looked at these labels in more detail, but do not per se make a link to any post-harvest treatment.

20

20

consumer quotes

Label most often not read

- 'It tells you which country it's from and the best-by date.' (low, 18-35)
- 'I can't recall to have ever looked on the back of such a label.' (low 35-50)
- 'It hasn't crossed my mind to read them. They're so obvious.' (high 18-35)
- 'Lemons are put in a bath to make them look nicer.' (high, 35-50)
- 'I read packaged food labels, but with this kind of product I don't look at it. With pure fruit and vegetables I think it says calories and stuff, but that information is not really relevant, because I already know this.' (high, 35-50)
- 'Labels have the barcode, for scanning and how much the weight/content is. But I never check it.' (high, 50-65)
- 'A lemon is a lemon, I'm not going to check that.' (high, 50-65)
- 'It tells if they're waxed or not.' (high, 50-65)


21

21

Evaluation Information on Post Harvest Treatment of Fruit/Vegetables

22

22



Process: 3 tiers of information

- During the discussion, participants were given 3 pieces of information to respond to, from quite general to more detailed and concrete.
- Each part was evaluated before going on to a next part with additional, more detailed information.
- This has clearly shown that acceptance of post-harvest additives is directly linked to the amount of information given.
- Too little leads to rejection and concern, too much leads to information overload.

23

23

Acceptance changes depending on level of detailedness and choice of words

order in which details information has been presented

first

second

last

'Stickers & labels indicate that the Fruit/Vegetables have undergone some form of treatment after harvest.'

"These stickers and labels indicate that a food additive has been applied to these produce after harvesting. With food additive we mean substances that are added to foods to improve a certain property of that food. Some of these additives are also referred to as "edible coatings" since they are food ingredients that may be safely consumed along with the produce."

"An example of post-harvest treatment is adding a vegetable coating to the skin of fruit and vegetables that you cannot taste or smell. This vegetable protection holds the moisture in the product longer, while oxygen remains outside. This way, the product can be kept 2-3 times longer. In this way, it contributes to a sustainable food chain, improves food quality and reduces food waste. The coating is made of vegetable material from the peel, seeds and flesh of fruit and vegetables that we already eat."

• Broad and multi-interpretable.

• Vagueness raises some doubt and leads to questions.

• The word Additives set off lots of alarm bells and leads to anxiety: damaging for the health?

• Coatings indicate an unnatural, chemical process.

• 'Safely consumed' is a claim that is not backed-up or proven: as such does not reassure.

• Detailed description reassures and sets at ease.

• Turns the strong negative feelings to neutral or even positive.

• Emphasises the naturalness, gives a credible explanation and mentions an important reason-why: sustainability.

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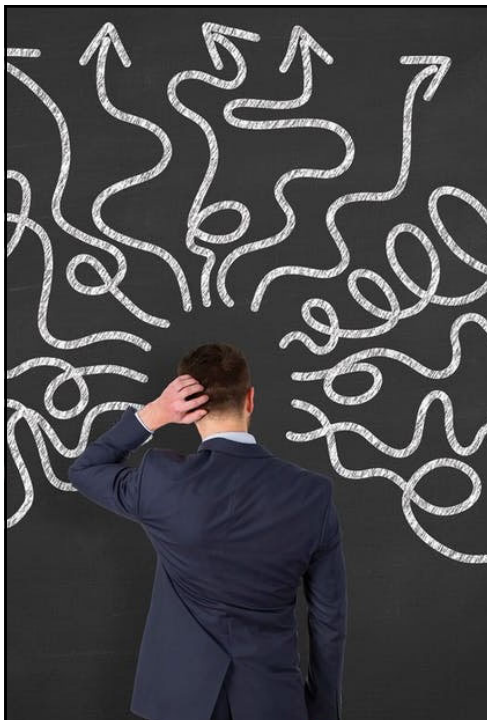
'Stickers & labels indicate that the Fruit/Vegetables have undergone some form of treatment after harvest.'



- To the vast majority, this first piece of information is a completely new message. They didn't know and didn't realise that a sticker could have any other function than just a brand/type/quality mark message.
- Therefore, most of them are quite surprised and their initial response skews easily towards mistrust and doubt.
- More-over, mentioning 'treatment' (behandeling) without further explanation easily opens up assumptions and associations on pesticides, chemicals and other unnatural process.

25

25



consumer
quotes

Doubt and questions....

- *'It's not clear how they are treated (whether they use some kind of poison/insecticide) but at least you know they are treated.'* (low, 18-35)
- *'The stickers look more like brand/type labels, I wouldn't recognise them as meaning fruit & vegetables have had a specific treatment.'* (low, 18-35)
- *'To increase the shelf life and keep them good longer, it has to be some sort of pesticide.'* (low 35-50)
- *'Doesn't sound too good for your health.'* (low 35-50)
- *'It's good that they warn you, because some pesticides give me acne.'* (low 35-50)
- *'That raises questions. It is safe or are they treated with an unsafe substance?'* (high 18-35)
- *'Treatment sounds unnatural, it's pure aesthetics for sales purposes, makes it unnatural.'* (high, 50-65)
- *'Salespeople want their products to look nice for a longer time.'* (high, 50-65)
- *'I've heard about blueberries undergoing a radio-active radiation process....'* (high, 50-65)

26

26



"These stickers and labels indicate that a food additive has been applied to these produce after harvesting. With food additive we mean substances that are added to foods to improve a certain property of that food. Some of these additives are also referred to as "edible coatings" since they are food ingredients that may be safely consumed along with the produce."



- The word 'food additives' and to some extent 'coatings' create a notion of an unnatural, chemical process. This conflicts heavily with the naturalness of produce.
- If given the choice, many would prefer no food additive above a longer freshness of the product.
- Even though it states that it can be safely consumed, many do not trust this at face value: who is making this claim and how can it be checked?
- Credibility only increases if it would be an independent source (food authority, etc). Neither the supermarket nor the producer are trusted in this. They are seen as having a personal, financial gain in this.

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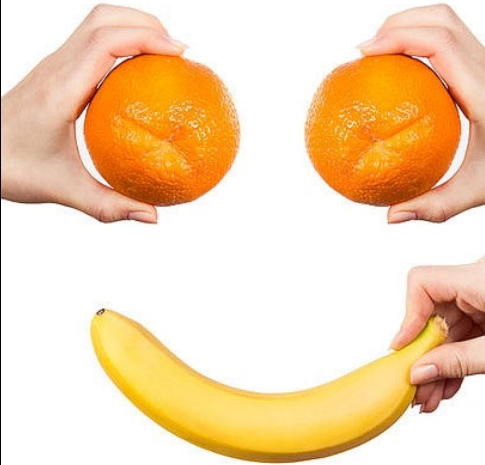
consumer
quotes

Additives & coating are off-putting

- 'Does this coating stay on the surface or does it permeate into the fruit itself?' (low, 18-35)
- 'It remains longer good, more sustainable and better for your wallet. But additives has a negative ring to it.' (low, 50-65)
- 'It would help if they would specify what this edible coating is made of.' (low, 50-65)
- 'Coating has a negative, unnatural connotation. Plant-based protection layer would be better.' (low, 50-65)
- 'I want to know what kind of additives and whether they're safe.' (high, 35-50)
- 'This gives more information and makes it clear that I would go for the produce that has not been treated.' (high, 35-50)
- 'It's conflicting: I want it to look nice, but I don't want additives.' (high, 35-50)
- 'The downside is that this treated produce may have been laying there much longer and therefore it's less fresh.' (high, 35-50)
- 'It's artificial, these are not natural ingredients. It may be edible, but it's not natural anymore.' (high, 50-65)
- 'It may keep it longer fresh, but it's something chemical that I don't want to put into my body.' (high, 50-65)
- 'If it can stay fresh longer than normal, it makes it unnatural per definition.' (high, 50-65)

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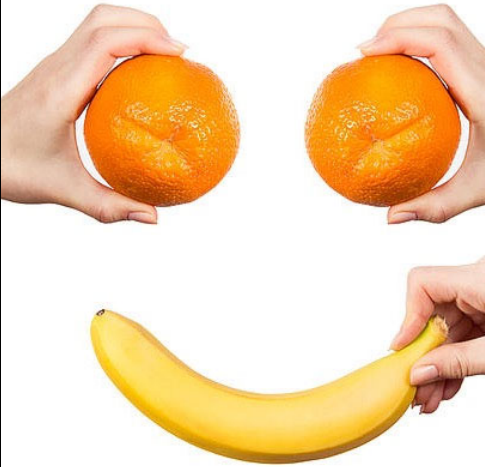


*"An example of post-harvest treatment is adding a vegetable coating to the skin of fruit and vegetables that you cannot taste or smell.
This vegetable protection holds the moisture in the product longer, while oxygen remains outside.
This way, the product can be kept 2-3 times longer.
In this way, it contributes to a sustainable food chain, improves food quality and reduces food waste.
The coating is made of vegetable material from the peel, seeds and flesh of fruit and vegetables that we already eat."*

- This piece of detailed information has a reassuring effect on the majority of consumers and is received positively.
- The previous sceptic to profound negative attitude, it turned around almost 180 degrees into very positive.
- It offers concrete, practical information that explains and reassures on food safety, sensory experience & naturalness
- And also invites in an easy way to contribute to sustainability and play a (small) role in doing one's part to reduce food waste.
 - the product is plant-based, meaning: natural and not chemical
 - it explains the sustainable effect which addresses the desire to contribute to it in an easy way
 - it makes concrete what the coating does.

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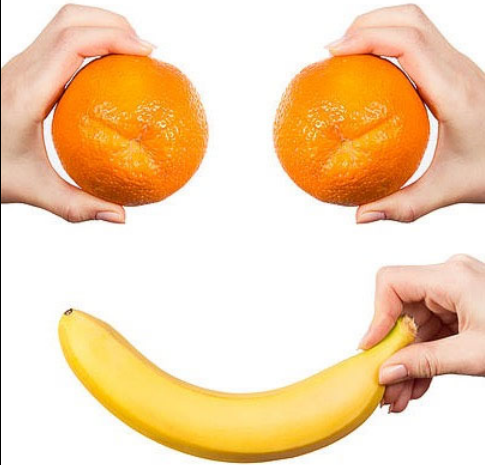


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In this way, it contributes to a sustainable food chain, improves food quality and reduces food waste.
The coating is made of vegetable material from the peel, seeds and flesh of fruit and vegetables that we already eat."*

- Nevertheless, some criticism remains:
 - 3 times longer sounds less credible. Perceptually it diminishes the freshness perception.
 - There's still the desire for a third party to give proof and provide the independent evidence. (Mostly among those who have a high food consciousness)
 - many have learned throughout the years that manufacturers tend to highlight their benefits and downplay or even omit their downsides.
 - organisations such as Keuringsdienst van Waarden, Food Safety Authorities or (independent) scientific/academic entities would remove hesitation and increase credibility.

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30



consumer quotes

"An example of post-harvest treatment is adding a vegetable coating to the skin of fruit and vegetables that you cannot taste or smell. This vegetable protection holds the moisture in the product longer, while oxygen remains outside. This way, the product can be kept 2-3 times longer. In this way, it contributes to a sustainable food chain, improves food quality and reduces food waste. The coating is made of vegetable material from the peel, seeds and flesh of fruit and vegetables that we already eat."

- 'Now I know it's not rubbish. I can keep my produce longer fresh and will waste less.' (low, 18-35)
- 'I'm surprised in a positive way. I didn't know this was possible!' (low, 35-50)
- 'I don't care where this coating comes from. As long as it's plant-based and from fruit & vegetables that we already eat, I know enough.' (low, 35-50)
- 'With 2 similar products, now I would choose the one with the coating. They've made it clear is completely natural and plant-based.' (low, 50-65)
- 'It's better now, but seeing is believing. How do they make this coating?' (high, 18-35)
- 'It sounds almost too good to be true. It has gone from something synthetic to plant-based and natural.' (high, 18-35)
- 'It sounds good now. It's no longer chemical but made from food. It's natural. And it makes you feel good about yourself because you're contributing to the environment.' (high, 35-50)
- 'It's fine with me, now I know it's natural. The coating sounded vague and chemical, but not anymore now.' (high, 35-50)
- 'If this is true, this would be absolutely amazing and quite revolutionary, because it truly decreases food waste. But I would need to do some research if this is indeed the case.' (high, 50-65)
- 'Three times longer, that could mean your produce is several weeks old....' (high, 50-65)

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There is a difference in importance between the pieces of information.

Description	Importance / Relevance	Argumentation
<i>"An example of post-harvest treatment is adding a vegetable coating to the skin of fruit and vegetables that you cannot taste or smell."</i>	Relatively high	<ul style="list-style-type: none"> • Does not have a negative influence on the food experience • It remains on the skin, so won't go into the product
<i>This vegetable protection holds the moisture in the product longer, while oxygen remains outside.</i>	Medium/Average	<ul style="list-style-type: none"> • Explains how the coating works • But is for some too detailed and technical.
<i>This way, the product can be kept 2-3 times longer.</i>	Relatively low	<ul style="list-style-type: none"> • 2-3 times sounds rather long and is paradoxical: long(er) shelf-life is counterintuitive to the notion of freshness (and thus taste). • Still too generic: some produce has a long shelf life already (eg. apples, while others are extremely perishable (eg. lettuce, spinach, berries)
<i>In this way, it contributes to a sustainable food chain, improves food quality and reduces food waste.</i>	Relatively high	<ul style="list-style-type: none"> • Appeals to the desire (or norm) to be more sustainable and, supported by the other claims makes it really easy to comply. • Gives 3 examples, and addresses both the individual as well as the collective
<i>The coating is made of vegetable material from the peel, seeds and flesh of fruit and vegetables that we already eat."</i>	Relatively high	<ul style="list-style-type: none"> • Reassurance of naturalness. • Takes away all fears/perceptions of 'chemical', 'processed', 'concerns of health-risks.' • For some, makes curious as to what it is and how this is achieved.

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Transparency and disclosure information

33

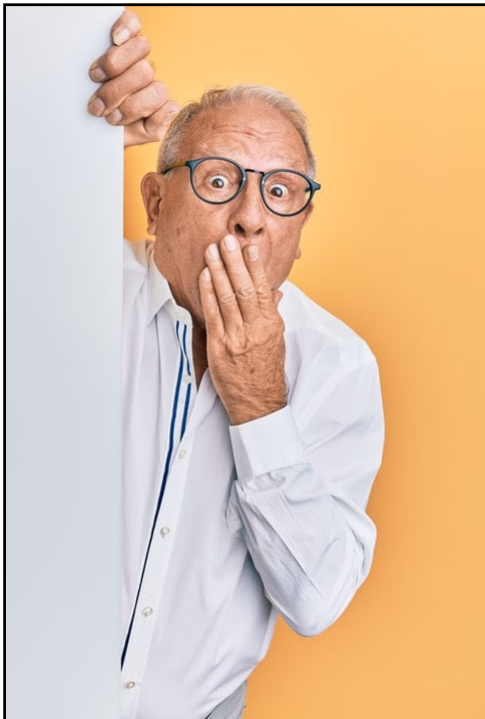
Legal requirements on disclosure

- *Food additives are used on many more fruits and vegetables than these, but this is not always visible on the products.*
- *ALL food additives have been extensively tested and approved by the European Food Safety Authority (EFSA), but it is not required by law to indicate the use of food additives on fresh fruit and vegetables, with the exception of some citrus fruits*



34

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The fact that applications are already used leads to some surprise, but not to real negative reactions

- Although most participants never heard of post harvest additives prior to this discussion, the majority is not that surprised that this is already applied to (some) produce.
 - The lack of actual surprise fits into a general attitude about food nowadays: consumers often don't get to see what actually happens to their food products or what is in/on it.
- Many rely on the notion that, if it would be harmful for the public health, it would have surely been banned already, because of regulations.
- Only few indicate that this would be a reason to be more cautious: checking information on labels, if possible.

35

35



The details on the citrus labels raise concerns

- Terms are used that are not clear and come across as chemicals.
- E-numbers, (although some know that they are also applicable to natural products) are seen as processed, unnatural and considered rather negative.
- Many indicate that, if given the choice between with or without additives, they would opt for without.

36

36



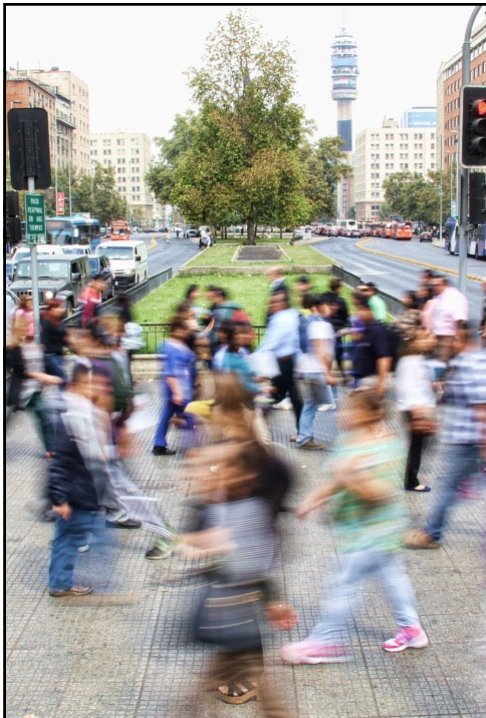
Labels on lemons raise suspicion

consumer quotes

- 'They had better state it's a plant-based wax, instead of these scary names and E-numbers.' (low, 35-50)
- 'All I need to know is that it's safe.' (low, 35-50)
- 'E-numbers sound unpleasant. Would rather say: plant-based layer to protect, instead of 'coating' (high, 18-35)
- 'This sounds like medication. Sound really weird to put on fruit.' (high, 18-35)
- 'This doesn't sound good. Like there's a catch somewhere.' (high, 18-35)

37

37



Some want to know the reason-why of (not) disclosing, but most are not that involved

- The topic raises a logical question: why is it sometimes obligatory to disclose and another time not? But for most, this question is not that important to personally go search for an answer.
- The majority has a rather low-involved and laid-back attitude:
 - in everyday life, checking every single type of fruit/vegetable is simply too much hassle,
 - so if it's approved by an official organisation, (like EFSA), most would simply rely on that,
 - and sometimes it's even downplayed: one would only consume it in small quantities, so the risk of causing harm is not that big.

38

38



consumer
quotes

Rather laid-back attitude

- *'It feels kind of sneaky that you don't always have to tell you used a coating.'* (low 18-35)
- *'I'd rather not know all these details, so I don't have to deal with it. Frankly, I rather put my head in the sand.'* (low, 35-50)
- *'I kind of expected that. But you've eaten fruit and vegetables for so long and never got ill, so it's safe.'* (low, 35-50)
- *'I don't need to know this about each single product. Too much detail. I would be fed up with that quite easily.'* (low 35-50)
- *'If you look at it, I recognise it now. After all, I did buy certain products simply because they looked better. But it helps to know if it's a plant-based coating.'* (low, 50-65)
- *'To me, it's more important that it is controlled well, but I don't mind that much that they don't mention it on every product.'* (low, 50-65)
- *'I am more lax. I would maybe google it. But nowadays there is so much information on every product.'* (high, 18-35)
- *'I'm not really surprised, there is something added to everything. I just hadn't really thought about it before, maybe I'll think about it tomorrow, but after a while it'll be forgotten again.'* (high, 18-35)
- *'If the EFSA has checked this, I believe it's okay. But I still think it should be the same for all kinds of products.'* (high, 50-65)

39

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Sources and detailedness of information: multi-modal, simple and easy obtainable.

- For most, the topic of Additives is of temporary interest and only raises awareness for a short period to time.
- It is seen as yet another thing one needs to take into account regarding food. For many, this is too cumbersome to continuously pay attention to.
- The preferred way of being informed is:
 - at the point of purchase (as this is where the decision is made)
 - preferably at a central place, not on each individual product
 - multi modal:
 - signs/information boards at the produce aisle
 - leaflets
 - QR codes (either on product or on shelf) that leads to further information
 - by an independent, objective, non-commercial source
- But many indicate not to want to be overloaded with information and would rather have an independent organisation regulate this and provide information for those who want to know the details.
- Additional (plastic) packaging material as a carrier for more. detailed information is rejected by all. Most would rather not be informed than to see more plastic on the shelf.

40

40



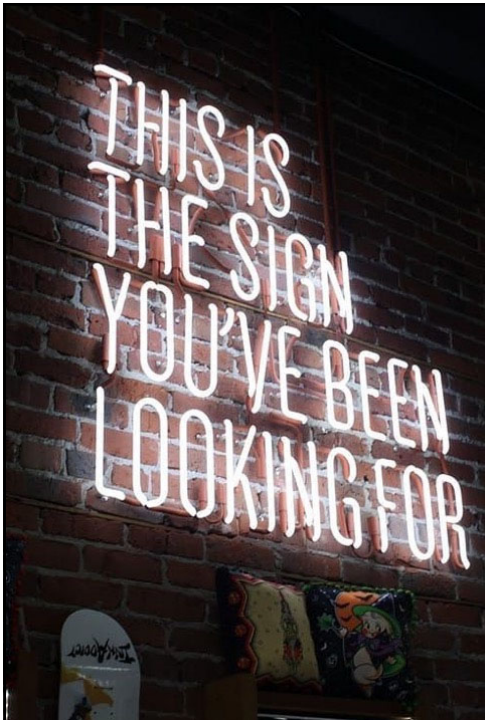
consumer
quotes

Source & place of information

- *'It should be information from the government, as they are independent.'* (low, 35-50)
- *'Put a sign at the shelf, or a poster.'* (low, 50-65)
- *'I find it more important that it's tested well, than that I'm informed about it.'* (low, 50-65)
- *'It shouldn't be the supplier. They only want to sell and won't be very transparent about it.'* (high, 18-35)
- *'I'm a bit lazy. I believe it'll be okay. Perhaps I would google it for a moment, but there's so much information on products these days. It's too much.'* (high, 18-35)
- *'In the store is where you decide, so that's the most obvious place to get informed.'* (high, 35-50)

41

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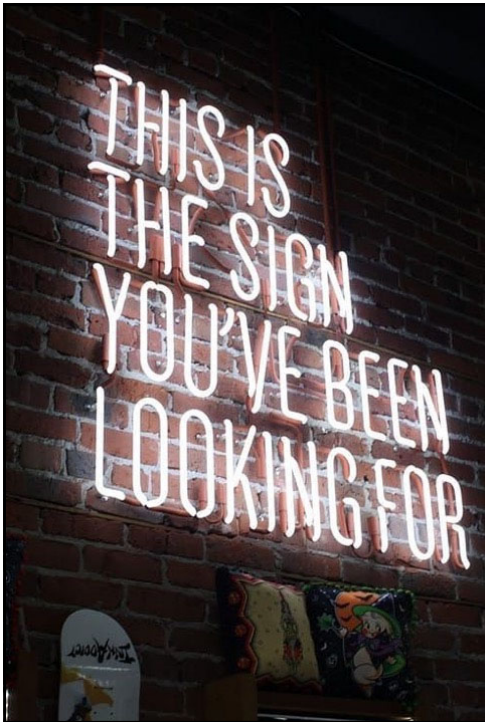


An indicator/symbol for post-harvest additives should be intuitively meaningful

- Reassuring:
 - green logo/design to indicate natural ingredients & food safety
 - 'thumbs up' or similar positive symbol to convey trust and reassurance
 - shape of a shield or other sign/symbol that indicates 'protection'
- Easy to understand:
 - single word or few words: easy to read, understand and remember
 - plain Dutch, to the point
 - Apeel is not understood by all and too cryptic
 - no difficult, scientific sounding terms.
- From a local, national source, i.e. Dutch government
 - Southern European countries or countries overseas are perceived as less trustworthy (fraude, less control on processes, etc.)

42

42



consumer
quotes

Keep it simple

- 'Put it next to the products, or on the shelf where it is shortly described.' (high, 18-35)
- 'Social media would not work for me, I would scroll right past it. I'm not in the mood to spend time on that.' (high, 18-35)
- 'It should make you feel safe.' (low, 50-65)
- 'To avoid confusing, it would be better to have one symbol/logo that applies to every product that has been treated. Too many different labels/stickers makes it confusing.' (low, 50-65)

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Conclusions & Recommendations

44



Actual awareness / knowledge of post-harvest additives is virtually non-existent

- For many, participating in this research is the first time they hear about post-harvest additives.
- There is a 'general notion' of knowing fruits/vegetables sometimes receive a special treatment, but this is mostly linked to aspects:
 - during growth (use of herbicides/pesticides vs organic)
 - during harvest (harvest before full ripeness)
 - during transportation (chill, using plastics)
- Some know about the wax layer on citrus fruits and/or apples, but perceive this mainly to be for cosmetic reasons: shine and colour

45

45



The perception and acceptance of additives strongly depends on the choice of words and the amount of information given

- Terms as *coating* and (*post harvest*) *additive* turn people off and are quite strongly rejected.
- They are counterintuitive to such natural products as fruit & vegetables
- They evoke associations of chemical, unnatural substances and are therefore perceived (very) undesirable.
- However, the attitude becomes much more positive when:
 - providing more information and stressing that a coating is completely natural (made from only natural ingredients) and thus harmless
 - indicating that it is beneficial to keep produce longer fresh and thus cause less food waste and contribute to being more sustainable.

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Acceptance changes depending on level of detailedness and choice of words

order in which
details information
has been presented

first

'Stickers & labels indicate that the Fruit/Vegetables have undergone some form of treatment after harvest.'



- Broad and multi-interpretable.
- Vagueness raises some doubt and leads to questions.

second

"These stickers and labels indicate that a food additive has been applied to these produce after harvesting. With food additive we mean substances that are added to foods to improve a certain property of that food. Some of these additives are also referred to as "edible coatings" since they are food ingredients that may be safely consumed along with the produce."



- The word Additives set off lots of alarm bells and leads to anxiety: damaging for the health?
- Coatings indicate an unnatural, chemical process.
- 'Safely consumed' is a claim that is not backed-up or proven: as such does not reassure.

last

"An example of post-harvest treatment is adding a vegetable coating to the skin of fruit and vegetables that you cannot taste or smell. This vegetable protection holds the moisture in the product longer, while oxygen remains outside. This way, the product can be kept 2-3 times longer. In this way, it contributes to a sustainable food chain, improves food quality and reduces food waste. The coating is made of vegetable material from the peel, seeds and flesh of fruit and vegetables that we already eat."



- Detailed description reassures and sets at ease.
- Turns the strong negative feelings to neutral or even positive.
- Emphasises the naturalness, gives a credible explanation and mentions an important reason-why: sustainability.

47

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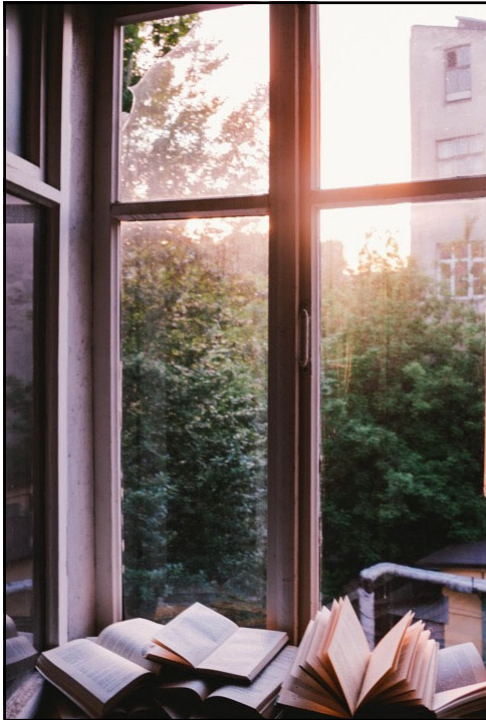


The topic faces a challenge to bridge the gap between level of information needed for acceptance and consumer's expected interest in it.

- Ensuring that the message about post harvest additives is received positively requires quite some detailed attention from the consumers.
- But many indicate that they probably would not want to spend that much time and attention on this topic in everyday life.
- So information needs to be concise, to-the-point, easy accessible, multimodal (at the shelf, online, on posters) and on demand, providing more details for those who are indeed keen to learn more.
- The majority indicates to rely on 'beacons of trust': third party organisation/institutions who are quality markers vowing for the safety of these additives: government, consumer organisations and/or independent scientific institutions.

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Short spike in interest, so important to reassure and build trust during this short 'window of opportunity'

- Consumers have a busy life and are bombarded with all kinds of information. This forces them to make choices and decisions on what information to pay attention to (if consciously noticed).
- The topic of post-harvest additives is for many 'yet another topic to think/worry about'.
- Quite a lot indicated that, as long as it's regulated, safe, and controlled, they do not have to be actively informed about it.
 - Most are satisfied, as long as the information is easily and readily available, when they would want to know more.
- For those who are more personally interested, it will likely still be only during a short moment: they want to get the info, want to understand what it is, decide and then move on with their daily lives.

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DE KUNST VAN GOEDE MARKETING 50

50

Annex 3 Survey questions (English)

Welcome + informed consent

Thank you for your interest in this survey! This research is conducted by Wageningen Food & Biobased Research. The goal of this survey is to get insight in how European consumers think about and deal with fresh fruits and vegetables. There are no right or wrong answers – we are interested in your personal opinion.

Statement of consent

- I am sufficiently informed about this research
- I know my answers will be used anonymously for the research goal described above;
- I know my answers are collected for data analysis, and will only be shared with the researchers involved in this project;
- I know the anonymized research data will be stored for a period of 10 years after this research has been conducted (in line with the legal retention period);
- I know that participation is voluntary, and that I can quit at any time without a statement of reason.

I am participating in this survey research and give consent for the use of my responses:

- ☐ YES
- ☐ NO

SECTION 1. Selection & Demographics

S1 Who is the primary decision maker of grocery purchases in your household?

- ☐ I do all of the grocery shopping
- ☐ I do most of the grocery shopping
- ☐ I share in the grocery shopping responsibility
- ☐ I do very little of the grocery shopping [TERMINATE]
- ☐ I do none of the grocery shopping [TERMINATE]

S2. What gender do you identify as?

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to answer

S3. What is your age?

... years

S4. What is the highest degree or level of education you have completed?

Country-specific answer categories – recode into low, middle, high

S5. What is the composition of your household?

- ☐ Single-person household
- ☐ Single parent household with child(ren)
- ☐ Multi-person household without child(ren)
- ☐ Multi-person household with child(ren)
- ☐ Other.

[Divide respondents randomly over 4 balanced subgroups]

SECTION 2. Awareness and knowledge

Q1 How often do you purchase fresh fruits and vegetables?

- ☐ 4 or more times a week
- ☐ 2 to 3 times a week
- ☐ once a week
- ☐ every 2 weeks
- ☐ once a month or less

Q2 How important are the following aspects to you when purchasing fresh fruits and vegetables?

- a. Quality (color, smell, taste, freshness, ripeness)
- b. Price
- c. Nutritional value
- d. Shelf life
- e. Convenience
- f. Seasonal
- g. Country/region of origin
- h. Environmentally friendly packaging
- i. trade
- j. Organic

Q3. How often do you read the information labels on (the packaging of) fresh fruits and vegetables?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Often
- ☐ Always

[Q4] Below you see examples of stickers / labels / logos that are sometimes used on fresh fruits and vegetables.

SHOW 4 LOGO STIMULI (simultaneously): Logo_[ABCD]_EN.png



Q4_A Which of these stickers / labels / logos have you seen before? (multiple answers possible)

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ None of these → go to Q5

Q4_B [Repeat logo for each checked box in Q4_A (one by one)]

What do you think this sticker / label / logo indicates?

- ☐ Produce type
- ☐ Produce brand
- ☐ Country/region of origin
- ☐ Genetically modified
- ☐ Ready-to-eat
- ☐ Extended shelf life
- ☐ Organic
- ☐ Fair trade
- ☐ Other, namely...
- ☐ I don't know

Q5. Below are potential points of improvement for the fresh fruits and vegetables you buy at the grocery store today. Please indicate how desirable each of these improvements are to you.

[7-pt scale: 1=not at all desirable, 7=very desirable]

- a. Improved taste and/or texture (e.g. juiciness, crispness)
- b. Visually more attractive
- c. Maintain freshness
- d. Extended shelf life
- e. Improved nutritional value
- f. Less use of pesticides
- g. Less plastic packaging
- h. Reduced environmental impact
- i. Reduced food waste

SECTION 3. Attitudes & disclosure needs

Imagine you are in the supermarket purchasing fresh F/V accompanied with the following message:

[SHOW MESSAGE]

BETWEEN-GROUPS: one message per group (zie ook excelfile)

GROUP 1: Message_1_EN.png

GROUP 2: Message_2_EN.png

GROUP 3: Message_3_EN.png

GROUP 4: Message_4_EN.png

Q6_A Have you ever encountered this message on fresh fruits or vegetables?

- ☐ Yes
- ☐ No → go to Q7

Q6_B on which produce?

_____ [required field]

Q7. Please indicate how you evaluate this message by answering the following statements.

[Semantic differential scale, 7-pt]

This message ...

- | | | |
|---|---|--|
| a. is very negative | – | very positive |
| b. is not clear at all | – | very clear |
| c. is very useless | – | very useful |
| d. is very unreliable | – | very reliable |
| e. would not at all affect my purchase decision | – | would strongly affect my purchase decision |

[MESSAGE EXPLANATION - 'RESET/NEUTRALIZE' 4 DISCLOSURE GROUPS]

This message indicates that a protective layer has been applied to fruits/vegetables after harvesting to improve their shelf-life. This layer is made from edible, plant-based materials that occur in the peel, seeds and pulp of fruits and vegetables, and is completely color-, odor- and tasteless. The protective layer keeps moisture inside the produce and oxygen out, which slows the rate of spoilage of fresh produce. This way, the quality of fruits and vegetables is maintained longer, and the amount of food waste reduced.

Q8. Do you think that currently there are fresh fruits and vegetables sold with such a protective layer?

- ☐ Definitely yes

- ☐ Probably yes
- ☐ Maybe, maybe not
- ☐ Probably not
- ☐ Definitely not

Q9. To me, applying a protective layer on fresh fruits and vegetables is / seems ...

[Semantic differential scale, 7-pt]

- | | | |
|------------------------------------|---|-------------------------------|
| a. Very negative | – | very positive |
| b. Very unnatural | – | very natural |
| c. Very useless | – | very useful |
| d. Very unhealthy | – | very healthy |
| e. Very dangerous | – | very safe |
| f. Very environmentally unfriendly | – | very environmentally friendly |
| g. Very uncommon | – | very common |

Q10. If such a protective layer was applied to the fresh fruits / vegetables you purchase, would you want to know about this?

- ☐ Yes
- ☐ No
- ☐ I don't care
- ☐ It depends →
 - Explanation: _____ [required]

Q11. Repeat Message_[1234]_EN.png (one message per group)

How do you evaluate this message, now that you know what it indicates?

[Semantic differential scale, 7-pt]

This message ...

- | | | |
|---|---|--|
| a. is not at all appropriate | – | highly appropriate |
| b. is very negative | – | very positive |
| c. is not clear at all | – | very clear |
| d. is very useless | – | very useful |
| e. is very unreliable | – | very reliable |
| f. would not at all affect my purchase decision | – | would strongly affect my purchase decision |

Q12. Consider the following alternatives to convey the same message (i.e. a protective layer has been applied to fresh F/V by which their shelf life is extended).

Which alternative do you find most suitable?

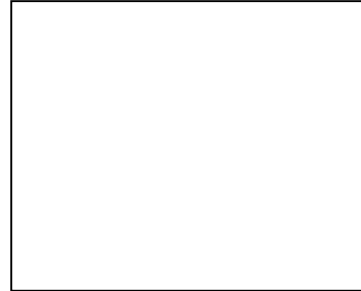
SHOW "Message_[1 t/m 4] _EN.png" (all messages simultaneously for all groups)

[POSITION ON SCREEN RANDOM]

Click on the alternative you find most suitable

Q13. Imagine you were given the task to inform consumers about this protective layer. Select three statements from the list below that you would definitely include in your message by dragging and drop these in the box.

1. Contains E471
2. Contains mono- and diglycerides of fatty acids
3. Made from plants
4. Edible
5. Color, odor-, and tasteless
6. Keeps moisture in and oxygen out
7. Keeps produce fresher longer
8. Reduces food waste
9. Reduces environmental impact
10. Approved by the EU



SECTION 4. Preferred disclosure channels & trusted sources

Q14. You will now see several examples of how several pieces of information about the protective layer on F/V could be communicated. Please evaluate each of these by answering the statements below the photo.

SHOW Mockup_[1 T/M 5]_EN.png

[ONE BY ONE – ORDER RANDOM]

[7-point scale: 1= completely disagree; 7=completely agree]

- a. This way of communication is appealing
- b. I would fail to notice this information

[Q15] **SHOW** QR_code_EN.png

Q15_A Which website do you think this QR code will link to?

- ☐ Retailer's website
- ☐ F/V produce supplier's website
- ☐ Government website
- ☐ Website from the branch organization of F/V producers
- ☐ Adjust per country: National Centre for Nutrition communication to consumers
- ☐ Adjust per country: national food safety authority
- ☐ Website from the European Food Safety Authority (EFSA)

- ☐ Other, namely...
- ☐ I don't know

Q15_B Which website would you **want** this QR code to link to?

- ☐ Retailer's website
- ☐ F/V produce supplier's website
- ☐ Government website
- ☐ Website from the branch organization of F/V producers
- ☐ Adjust per country: National Centre for Nutrition communication to consumers
- ☐ Adjust per country: national food safety authority
- ☐ Website from the European Food Safety Authority (EFSA)
- ☐ Other, namely...
- ☐ I don't want to be linked to any website

Q15_C Would you scan this QR code / visit the website?

- ☐ Definitely yes
- ☐ Probably yes
- ☐ Maybe, maybe not
- ☐ Probably not
- ☐ Definitely not

Q16. In the past year, which of the sources below have you consulted to learn more about foods? (multiple answers possible)

- ☐ None
- ☐ Retailer's website
- ☐ Producer's website
- ☐ Government website
- ☐ Adjust per country: National Centre for Nutrition communication to consumers
- ☐ Adjust per country: national food safety authority
- ☐ Website from the European Food Safety Authority (EFSA)
- ☐ Wikipedia
- ☐ Social media (e.g. Facebook, Instagram)
- ☐ Newspaper / magazine articles
- ☐ Podcasts
- ☐ Other, namely...

Q17. To what extent do you agree with the following statements?

1=completely disagree, 7 = completely agree

- a. Nowadays, food products are full of harmful substances
- b. Food products sold in Dutch [German/Belgium/French/Spanish] supermarkets are safe to eat

- c. Food products sold in European supermarkets are safe to eat
- d. National authorities keep me safe from food risks
- e. European regulations keep me safe from food risks

Q18 To what extent do you trust the following sources for information on food safety?

[7-pt scale: 1=Do not trust at all, 7 = totally trust + 8 = I don't know]

- a. Scientists
- b. Consumer organisations
- c. Farmers
- d. National authorities
- e. EU institutions
- f. NGOs
- g. Journalists
- h. Supermarkets and restaurants
- i. Food industries
- j. Celebrities, bloggers, influencers
- k. Google

Q19. If the European Food Safety Authority (EFSA) and the European Commission have approved the use of a protective layer, then the presence of this layer on fresh fruits and vegetables ...

- ☐ should be communicated to consumers
- ☐ does not have to be communicated to consumers

SECTION 5. Additional question (from focus groups)

Q20. In the past month, how often did you perform the following actions?

		1 Never (0 times)	2 Rarely (1-3 times a month)	3 Sometimes (1-2 times a week)	4 Often (3-5 times a week)	5 Always (every day)
1	Eating a meal without meat					
2	Buying local foods					
3	Buying seasonal foods					
4	Avoiding genetically modified foods					
5	Avoid plastic packaging					
6	Avoiding preservatives in foods					
7	Eating organic foods					
8	Choose food brands that employ sustainable business practices					

Annex 4 Survey results per question

Apeel consumer research – European survey

Results per question

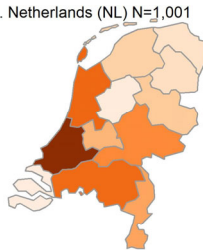
1

Survey respondents

A. COUNTRIES



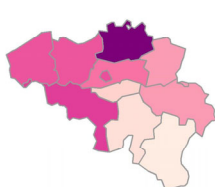
B1. Netherlands (NL) N=1,001



B2. Germany (DE) N=1,003



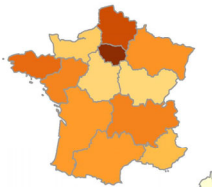
B3. Belgium (BE) N=1,017



B4. Spain (ES) N=1,001



B5. France (FR) N=1,013



*Nationally representative samples
(age, gender, education level)*

Source: © EuroGeographics for the administrative boundaries

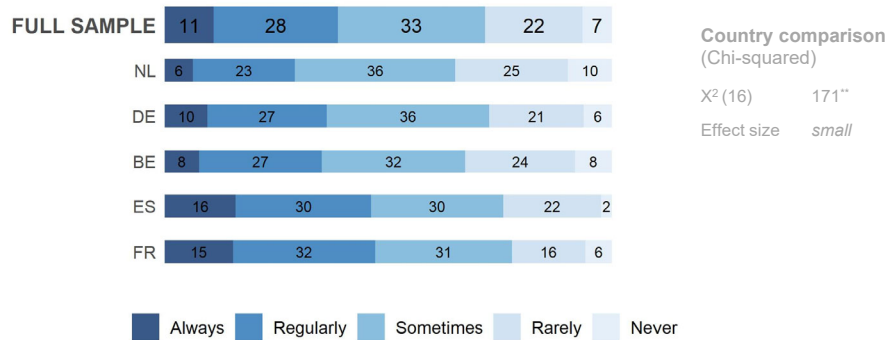
2

Demographics

	FULL SAMPLE	NL	DE	BE	ES	FR
Sample size <i>N respondents</i>	5,035	1,001	1,003	1,017	1,001	1,013
Survey language		Dutch	German	Dutch (57%)/ French (43%)	Spanish	French
Gender <i>N (%) respondents</i>						
Male	2,524 (50)	500 (50)	509 (51)	530 (52)	506 (51)	479 (47)
Female	211,488 (49)	497 (50)	489 (49)	484 (48)	492 (49)	526 (52)
Other/prefer not to say	23 (0)	4 (0)	5 (0)	3 (0)	3 (0)	8 (1)
Age <i>M ± SD years</i>	47.5 ± 16.9	48.2 ± 17.2	47.9 ± 17.2	46.5 ± 16.8	46.9 ± 16	47.9 ± 17.2
Range	18-85	18-84	18-85	18-84	18-85	18-82
Education level <i>N (%) respondents</i>						
Low	1295 (26)	185 (18)	330 (33)	228 (22)	207 (21)	345 (34)
Middle	1868 (37)	364 (36)	459 (46)	361 (35)	416 (42)	268 (26)
High	1870 (37)	450 (45)	214 (21)	428 (42)	378 (38)	400 (39)
Unknown	2 (0)	2 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Household composition <i>N (%) respondents</i>						
Single person household without children	1,221 (24)	263 (26)	302 (30)	259 (25)	138 (14)	259 (26)
Single-parent household with child(ren)	642 (13)	91 (9)	81 (8)	150 (15)	175 (17)	145 (14)
Multi-person household without children	1,646 (33)	383 (38)	358 (36)	311 (31)	293 (29)	301 (30)
Multi-person household with child(ren)	1,448 (29)	254 (25)	255 (25)	276 (27)	370 (37)	293 (29)
Other	78 (2)	10 (1)	7 (1)	21 (2)	25 (2)	15 (1)

Awareness & knowledge

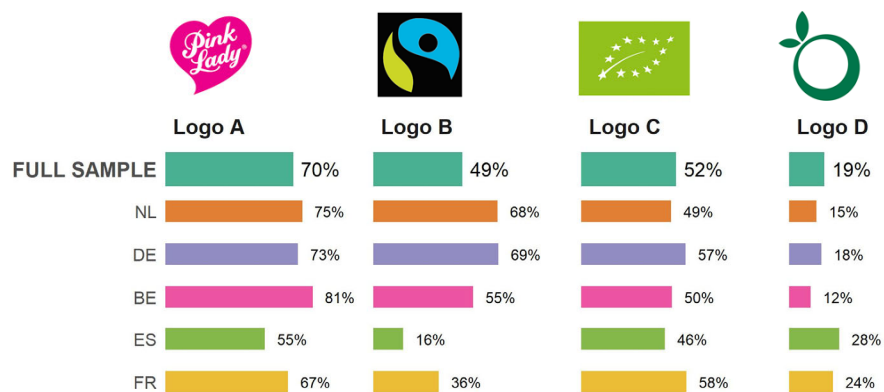
Q3. How often do you read the information labels on (the packaging of) fresh fruits and vegetables?



Majority of consumers (>60%) do not regularly read F/V information labels

- Similar pattern across countries
- Dutch consumers read F/V information labels relatively least frequently

Q4_A. Have you seen this sticker/label/logo before?

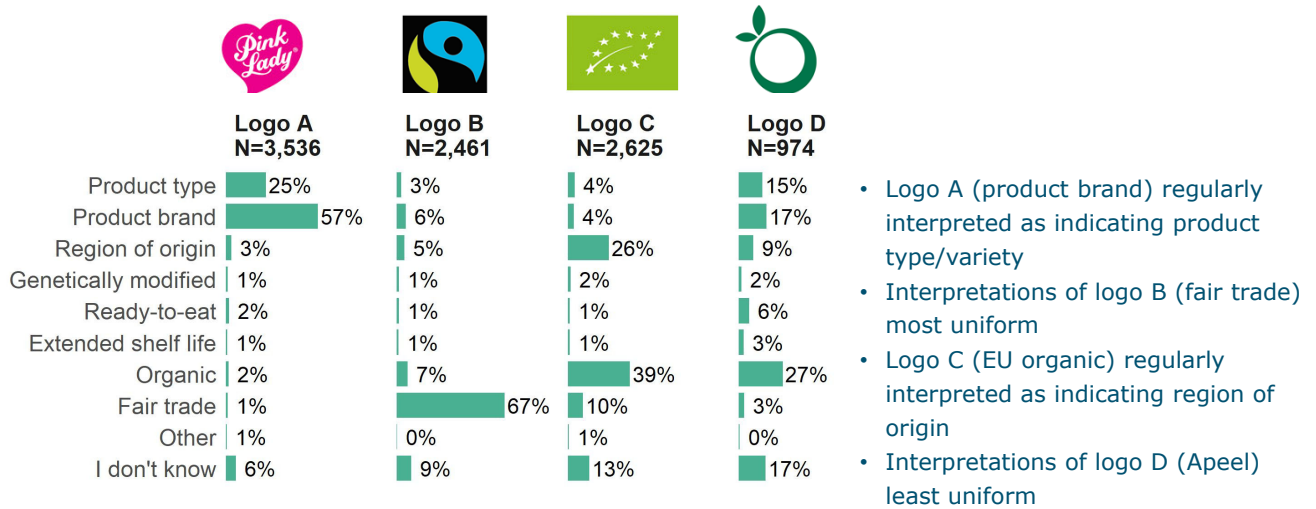


Country comparison per logo (Chi-squared)	$X^2(4)$	191 ^{**}	814 ^{**}	45.3 ^{**}	109 ^{**}
	Effect size	<i>small</i>	<i>medium</i>	<i>negligible</i>	<i>small</i>

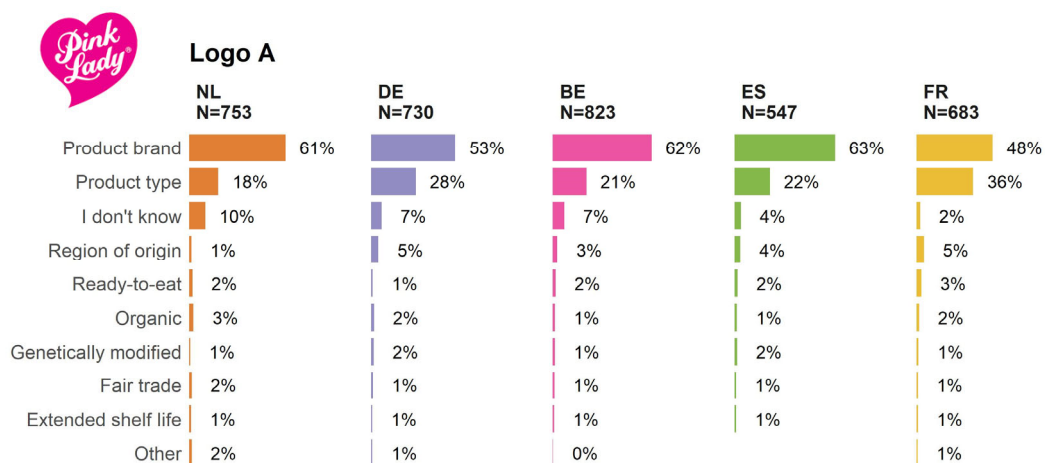
Logo A (Pink Lady) recognized most often, logo D (Apeel) least often

- Logos A and B recognized less often by Spanish consumers
- Logo D recognized relatively more often by French and Spanish consumers

Q4_B. (If yes) what do you think this label/sticker/logo indicates?



Q4_B. (If yes) what do you think this label/sticker/logo indicates?

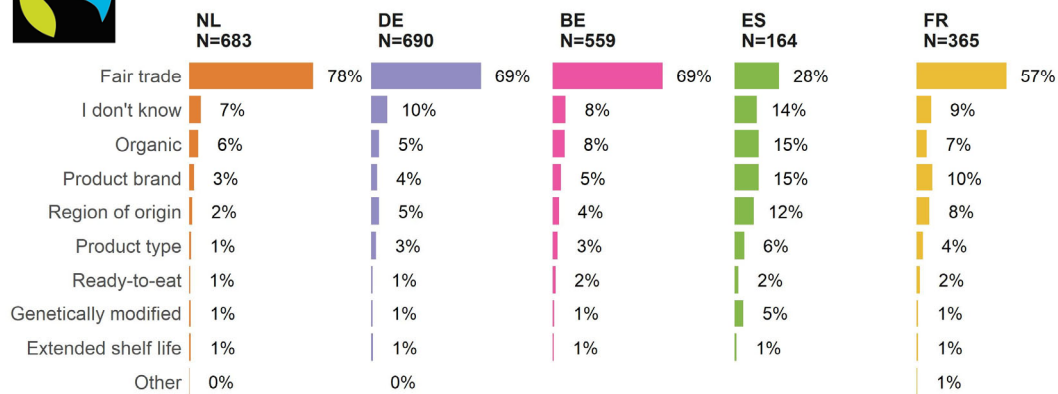


Similar pattern across countries

Q4_B. (If yes) what do you think this label/sticker/logo indicates?



Logo B

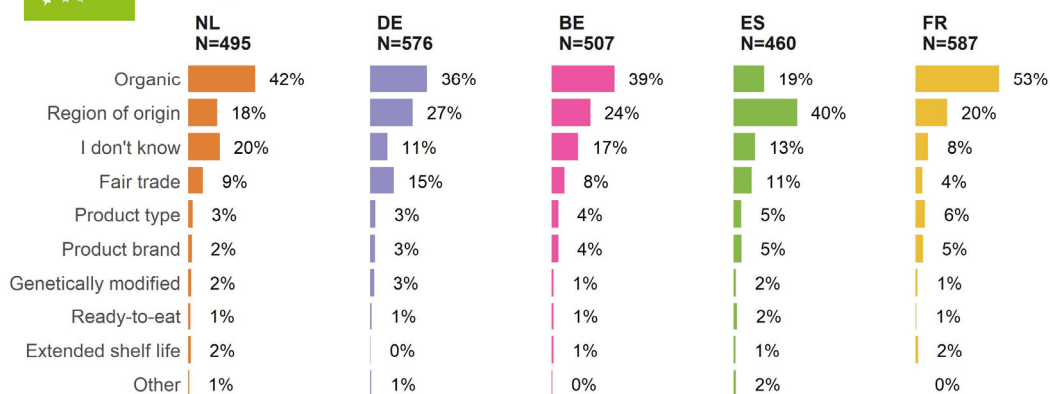


Fair trade logo least familiar to Spanish consumers

Q4_B. (If yes) what do you think this label/sticker/logo indicates?

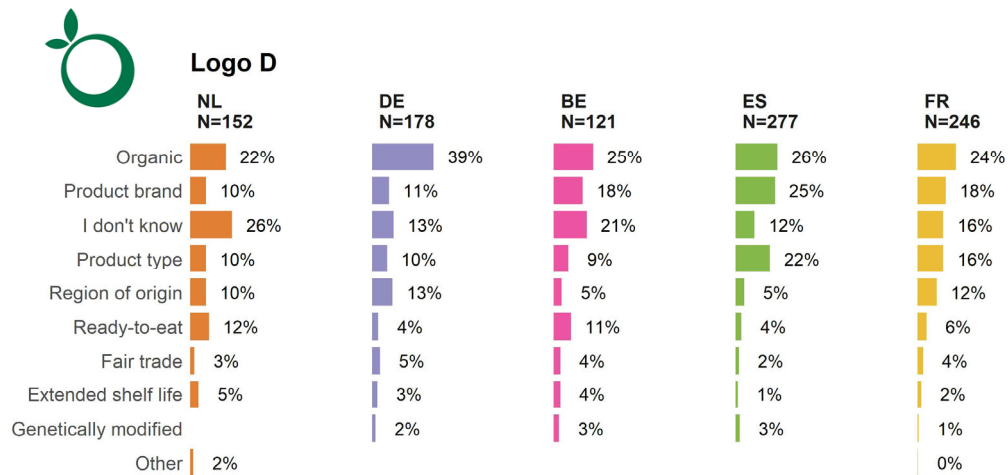


Logo C



EU organic logo most often interpreted as indicating region of origin by Spanish consumers

Q4_B. (If yes) what do you think this label/sticker/logo indicates?



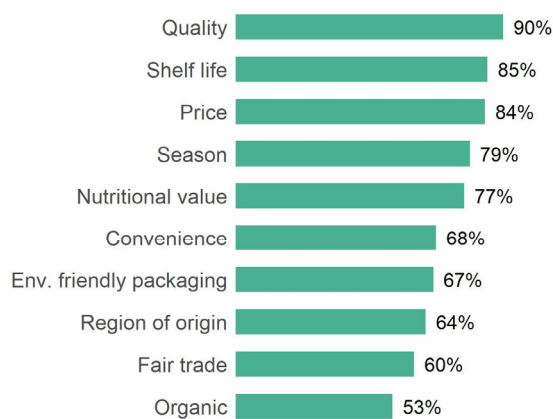
Variable interpretations for Apeel logo in all countries

11

Perceived value of benefits of food additives (regardless of additive knowledge)

12

Q2. How important are the following aspects to you when purchasing fresh F/V?



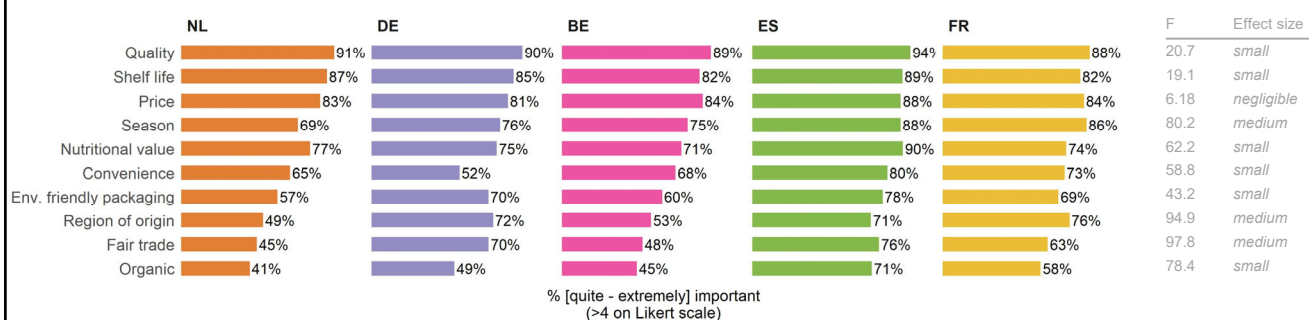
Quality, shelf life and price are (relatively) most important

Comparisons (ANOVA)

Effect	F	Effect size
Aspect	893**	large
Country	97.9**	medium
Aspect x Country	39.4**	small

13

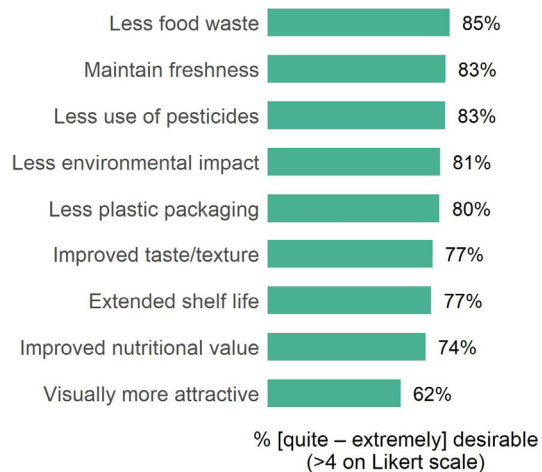
Q2. How important are the following aspects to you when purchasing fresh F/V?



- Top 5 consistent across countries: Quality, shelf life, price, season, nutritional value
 - Only exception: French consumers value region of origin more than nutritional value
- Overall higher ratings from Spanish consumers (general pattern)
- Convenience relatively less important to German consumers

14

Q5. Desirability of F/V improvements



All proposed F/V improvements are highly valued

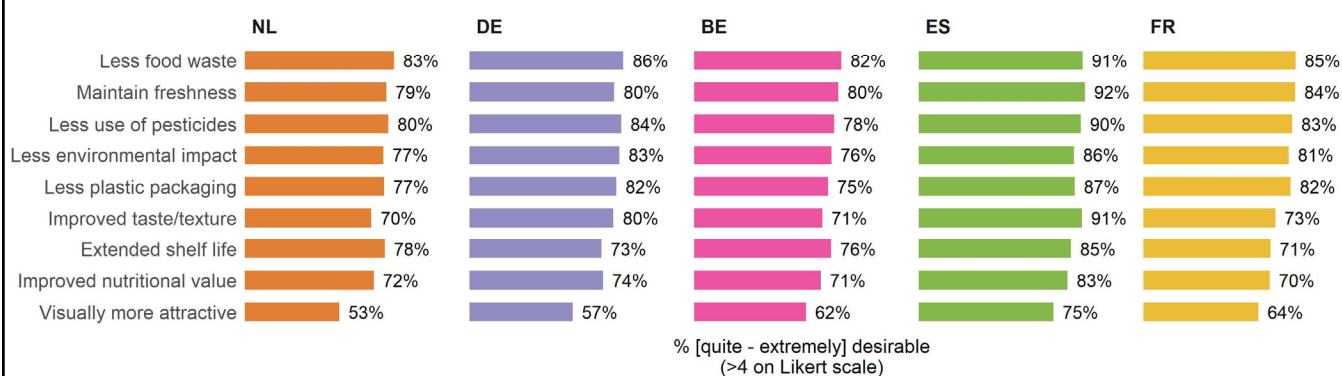
- Reducing food waste most desirable
- Visual appearance least desirable

Comparisons (ANOVA)

Effect	F	Effect size
Improvement	472**	medium
Country	60.6**	small
Improvement x Country	10.3**	negligible

15

Q5. Desirability of F/V improvements



- Similar pattern across countries
 - Overall higher ratings from Spanish consumers (general pattern)

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Disclosure

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Initial disclosure messages (between-subjects)

Message A

Treated with E-471

Message B

Treated with mono-
and diglycerides of
fatty acids

Message C

Protective layer applied
for longer shelf life

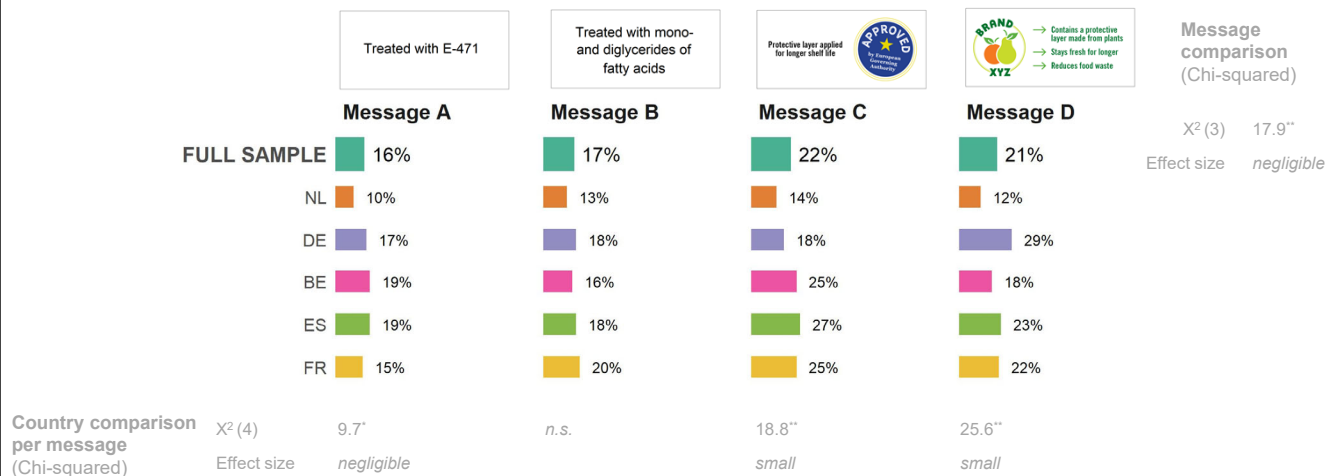


Message D



18

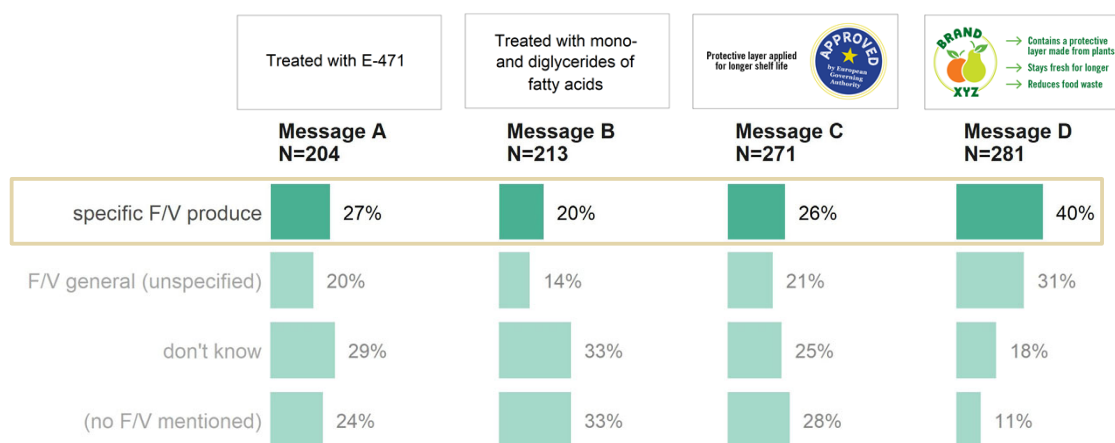
Q6_A. Have you ever encountered this message on fresh F/V?



15-20% of consumers indicate to recognize the disclosure messages

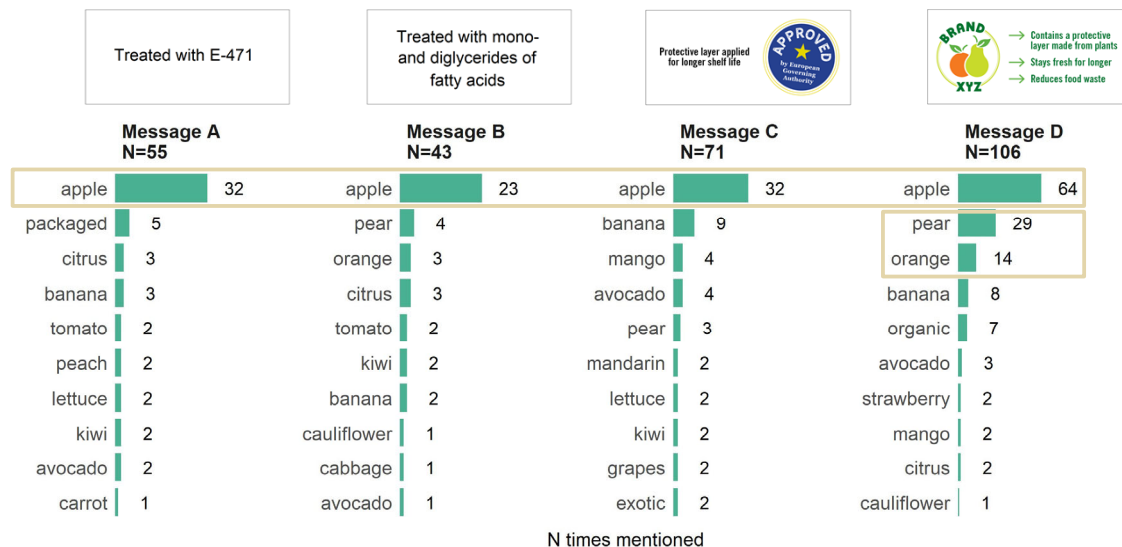
- Similar patterns across countries
- Relatively lower recognition in Dutch consumers

Q6_B. (If yes) On which produce? (open question)



(see slide 21 for interpretation)

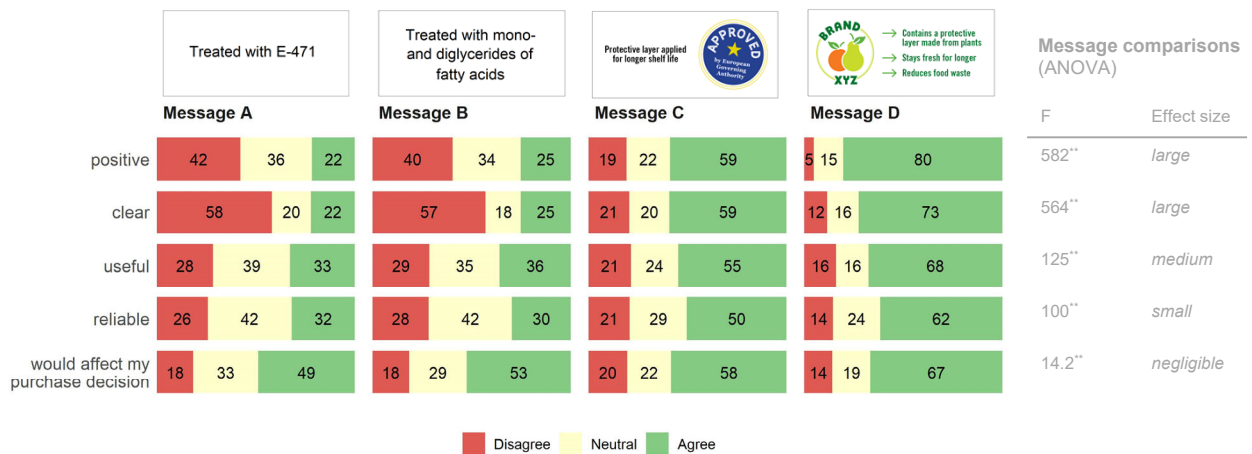
Q6_B. (If yes) On which produce? *Specific responses*



Interpretation Q6

- (Very) little awareness of existing (ingredient) disclosure methods
- About a fifth of consumers indicated they had seen disclosure messages on fresh F/V before, but reliability of 'yes'-responses is questionable
 - Non-existent disclosure messages (C/D) recognized equally often as existing messages (A/B)
 - Majority of yes-responders did (could?) not specify on which produce when prompted
 - Frequency of 'apple' responses overall, and of 'pear'/'orange' responses for Message D, suggest a priming effect rather than actual recognition
 - *Pink Lady* and *Apeel* logo in Q4 activated apple associations in all respondents
 - 'Brand XYZ' logo (Message D) additionally triggered 'pear' and 'orange' associations

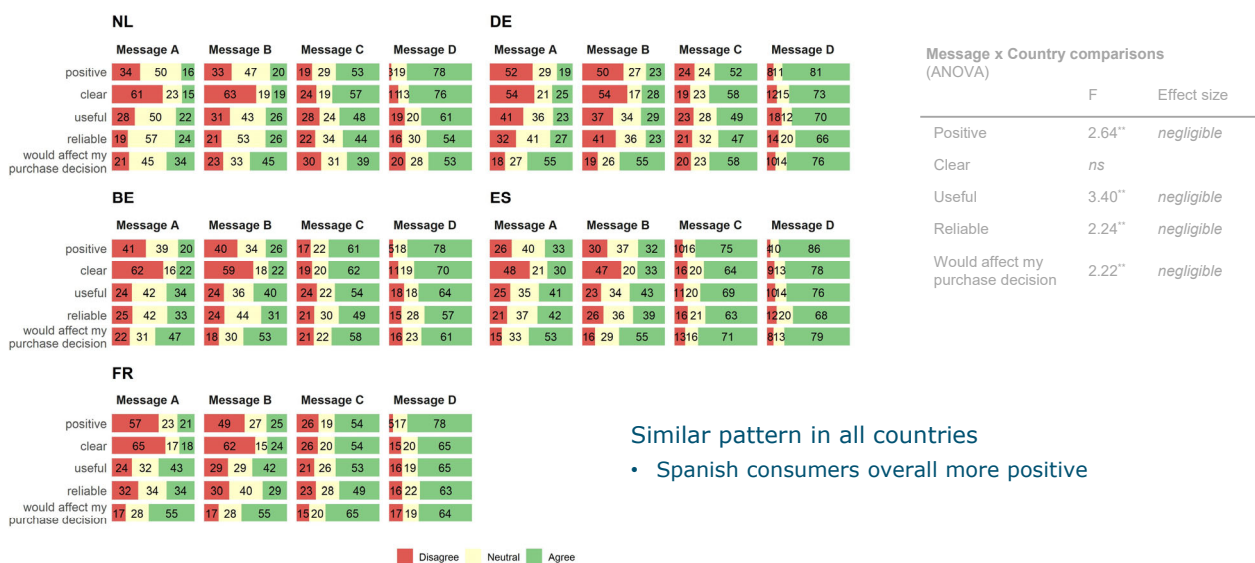
Q7. How do you evaluate this message?



- Ingredient disclosure messages (current EU legislations) are overall negatively evaluated
- Alternative disclosure messages are overall positively evaluated; the most detailed message is evaluated best

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Q7. How do you evaluate this message?



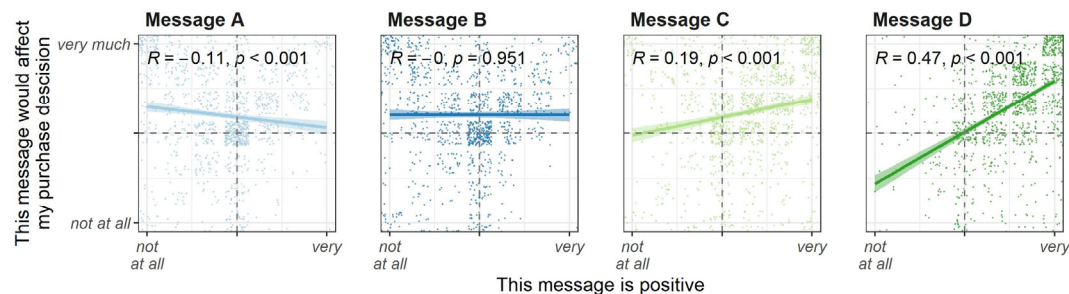
Similar pattern in all countries

- Spanish consumers overall more positive

24

Q7. Correlations:

'would affect my purchase decision' vs. 'this message is positive'

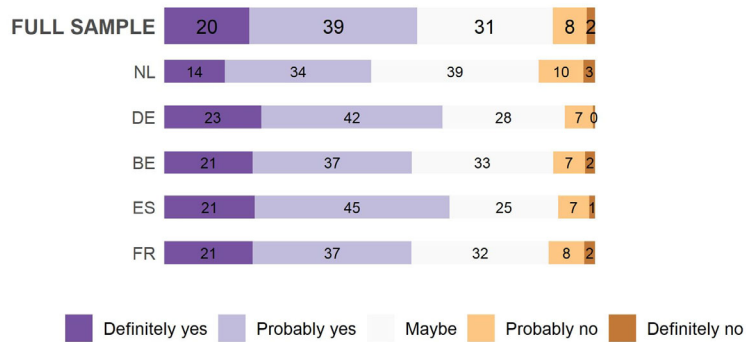


- Negative correlation in subgroup A: consumers who indicate that the message would affect their F/V purchase decision are mostly negative
- Positive correlation in subgroups C and D: consumers who indicate that the message would affect their F/V purchase decision are mostly positive
 - Message A may be a barrier for purchasing treated F/V
 - Message C and D may be potential drivers for purchasing treated F/V

Full disclosure message (same for all subjects)

"This message indicates that a protective layer has been applied to fruits/vegetables after harvesting to improve their shelf-life. This layer is made from edible, plant-based materials that occur in the peel, seeds and pulp of fruits and vegetables, and is completely color-, odor- and tasteless. The protective layer keeps moisture inside the produce and oxygen out, which slows the rate of spoilage of fresh produce. This way, the quality of fruits and vegetables is maintained longer, and the amount of food waste reduced."

Q8. Do you think such protective layers are currently being applied to fresh F/V?



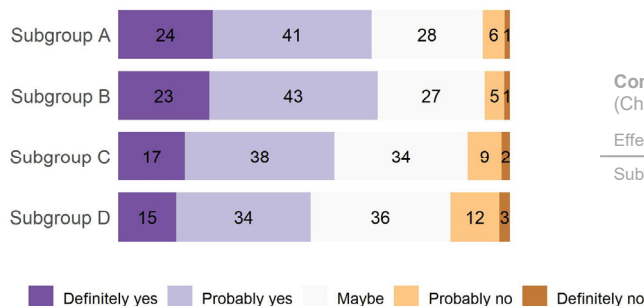
Comparison
(Chi-squared)

Effect	X ²	Effect size
Country	106**	small

Majority of consumers (59%) deem it likely that post-harvest additives are currently used on fresh F/V

- Perceived likelihood lowest in Dutch consumers

Q8. Do you think such protective layers are currently being applied to fresh F/V?



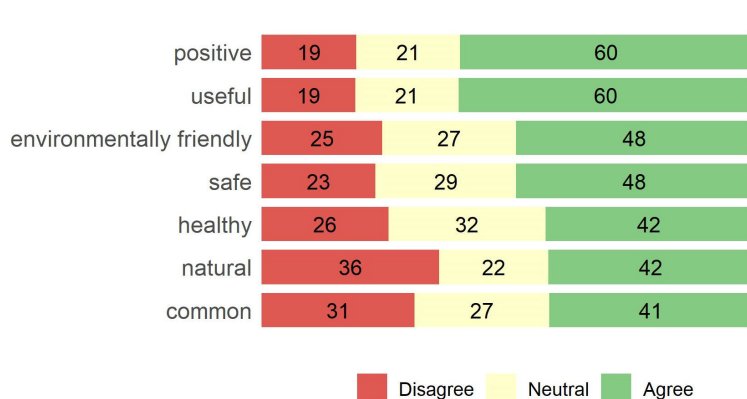
Comparison
(Chi-squared)

Effect	X ²	Effect size
Subgroup	139**	small

Initial disclosure message induces a small response bias

- Perceived likelihood higher after ingredient disclosure (message A/B)

Q9. Applying a protective layer to fresh F/V is/seems..

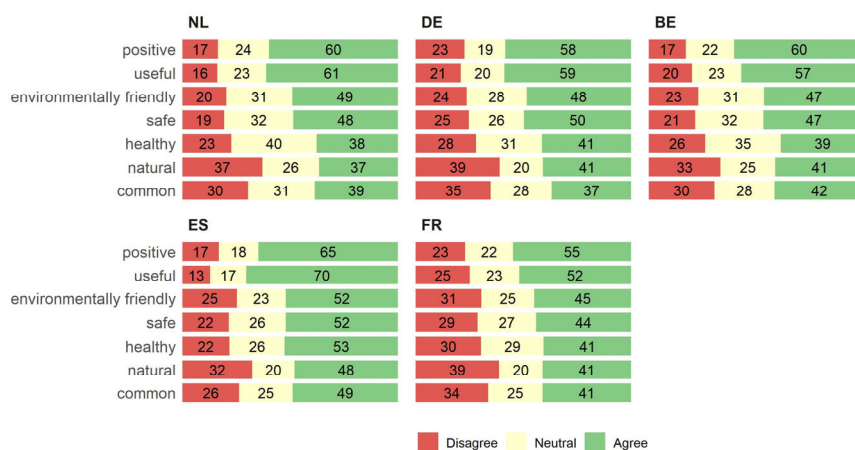


Comparisons (ANOVA)

	F	Effect size
Statement	381**	medium
Subgroup	24.4**	small
Country	12.7**	small
Statement x Subgroup	10.4**	negligible
Statement x Country	7.57**	negligible
Subgroup x Country	ns	
Statement x Subgroup x Country	1.64**	negligible

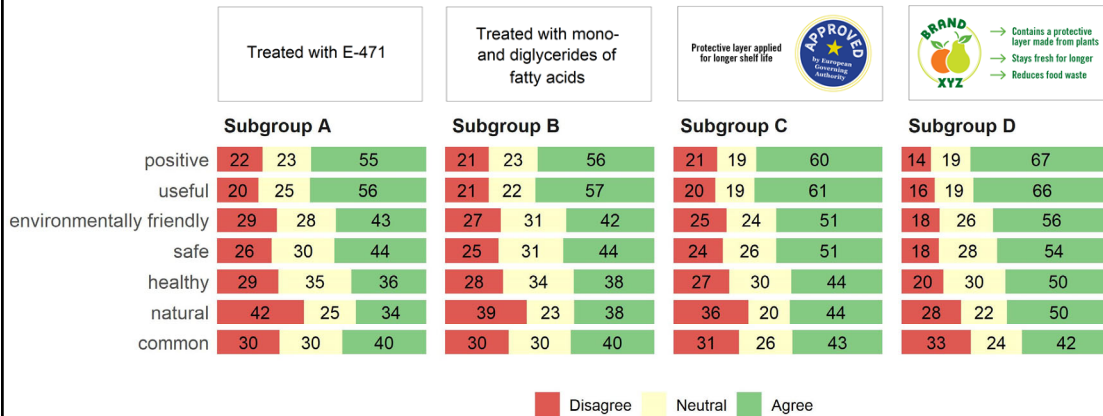
- Majority of consumers (60%) find the use of post-harvest additives on fresh F/V positive and useful
- Somewhat less agreement on healthiness, naturalness and commonness

Q9. Applying a protective layer to fresh F/V is/seems..



- Similar pattern across countries
 - Spanish consumers agree more overall (general pattern)

Q9. Applying a protective layer to fresh F/V is/seems..

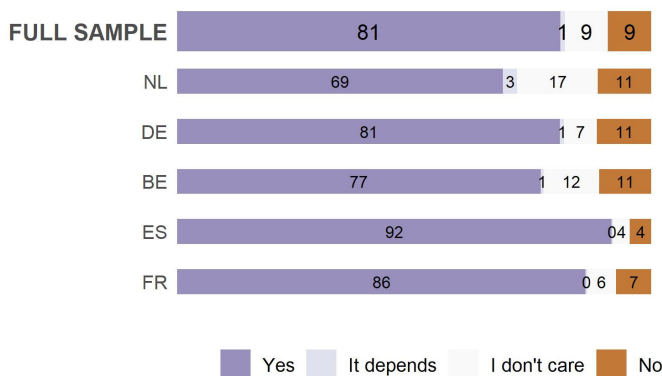


Initial disclosure message induces small response bias

- Ingredient disclosure (messages A & B) negatively impacts attitudes toward post-harvest additive use (but majority still thinks post-harvest additives are positive and useful after full disclosure)

31

Q10. Would you want to know if a protective layer is applied to the F/V you purchase?



Comparisons
(Chi-squared)

Effect	X ²	Effect size
Country	256**	small
Subgroup	ns	

Clear wish for transparency

- Dutch consumers relatively more inclined to answer 'I don't care'
- Disclosure needs not affected by initial disclosure message

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Q10. Would you want to know if a protective layer is applied to the F/V you purchase?

■ Exploring 'it depends' responses (N=51):

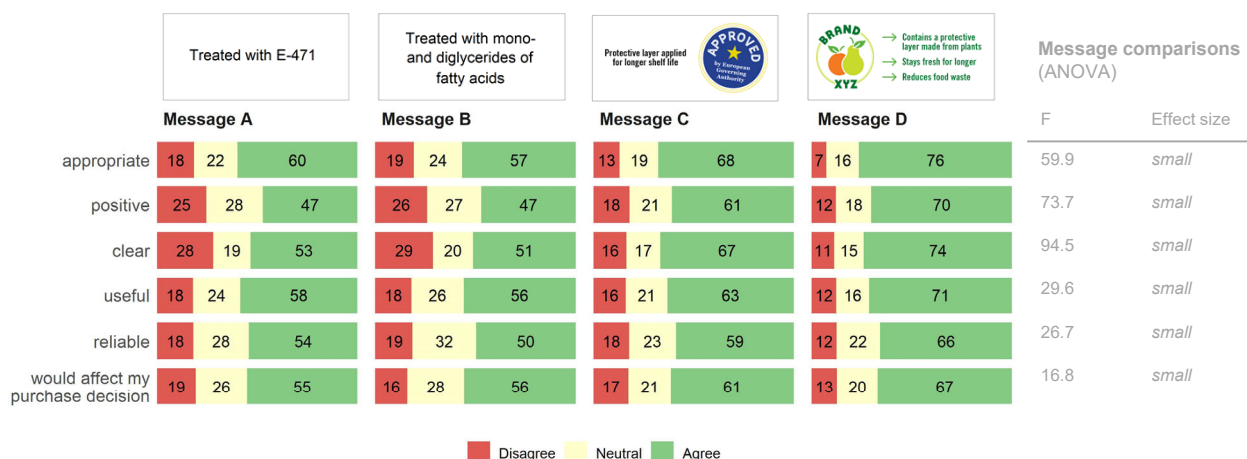
Is it healthy? – Is it safe? – What is it made of? – Is it edible? – Does it affect the taste? – I want to know more about the layer – How long has it been in the store? – Do I need to peel it? – if it affects the price

■ Some of these responses suggest question was misread as “would you want to **eat** produce with a protective layer?”

- Majority of 'it depends' responses (N=36) comes from Dutch-speaking consumers (NB lexical overlap between *weten* 'know' and *eten* 'eat')

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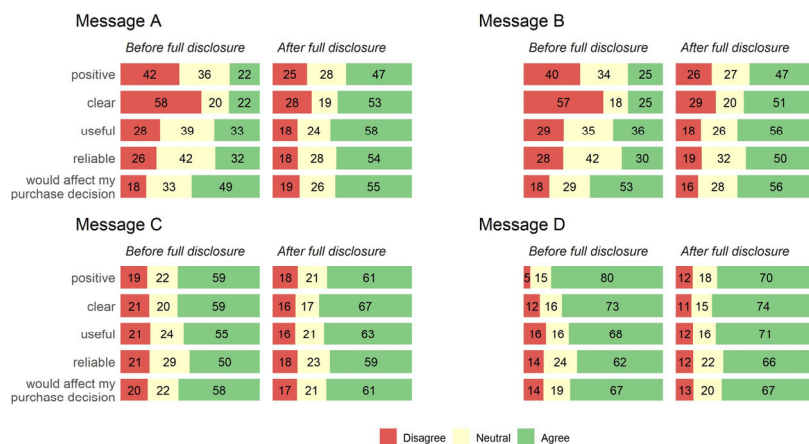
Q11. Message evaluations after full disclosure



- Differences between messages reduced after full disclosure (small effects vs. medium to large effects before full disclosure)
- Ingredient disclosure messages evaluated less positively than alternatives

34

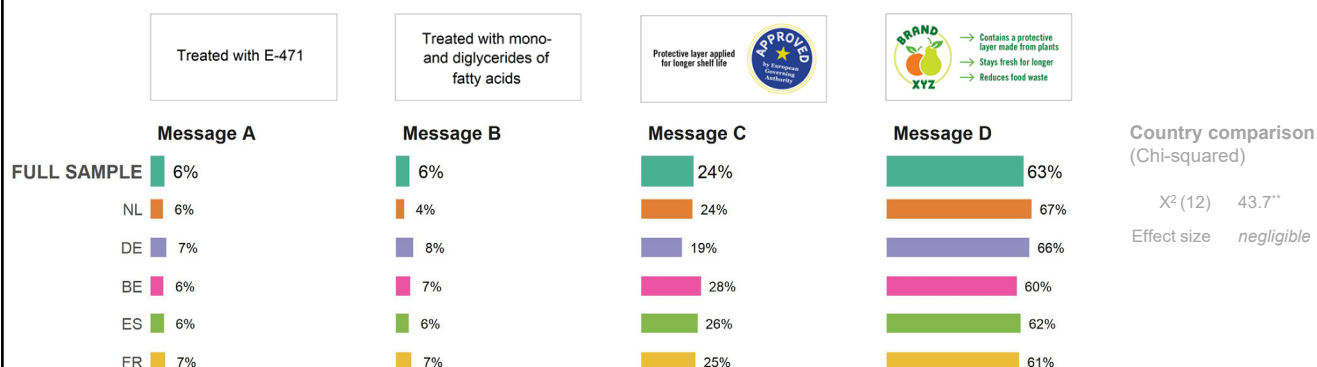
Message evaluations before vs. after full disclosure (Q7 vs. Q11)



- Messages A and B evaluated more positively after disclosure (though not as positively as alternatives)
- Message D evaluated as somewhat less positive (though not less clear, useful or reliable) after full disclosure

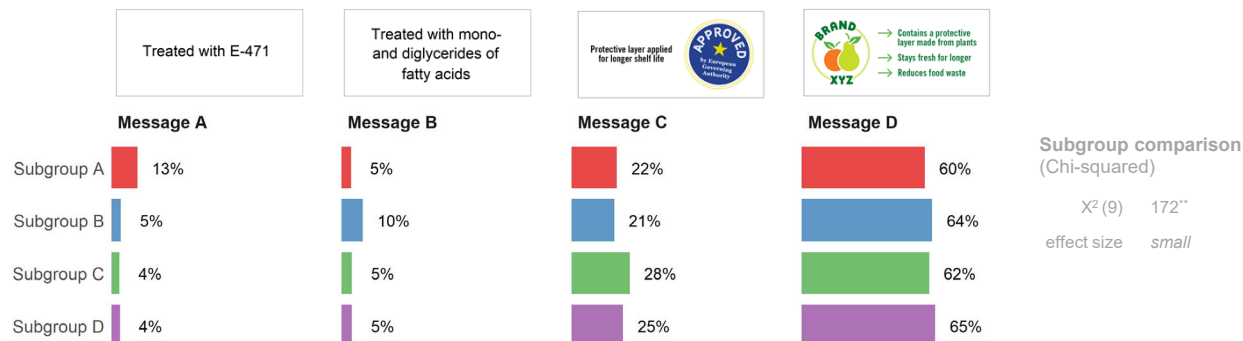
• Full disclosure may have been perceived as redundant / consumers possibly felt they were answering the same questions twice

Q12. Preferred message



- Clear preference for disclosure message D
- Ingredient disclosure messages (A/B) are least preferred
 - Same pattern across countries

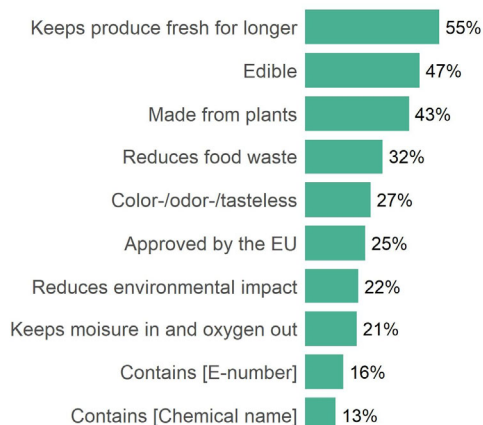
Q12. Preferred message



- Initial disclosure induces small response bias: messages are preferred relatively more often if these were seen initially (= priming effect)
 - But does not change the overall preference for message D

37

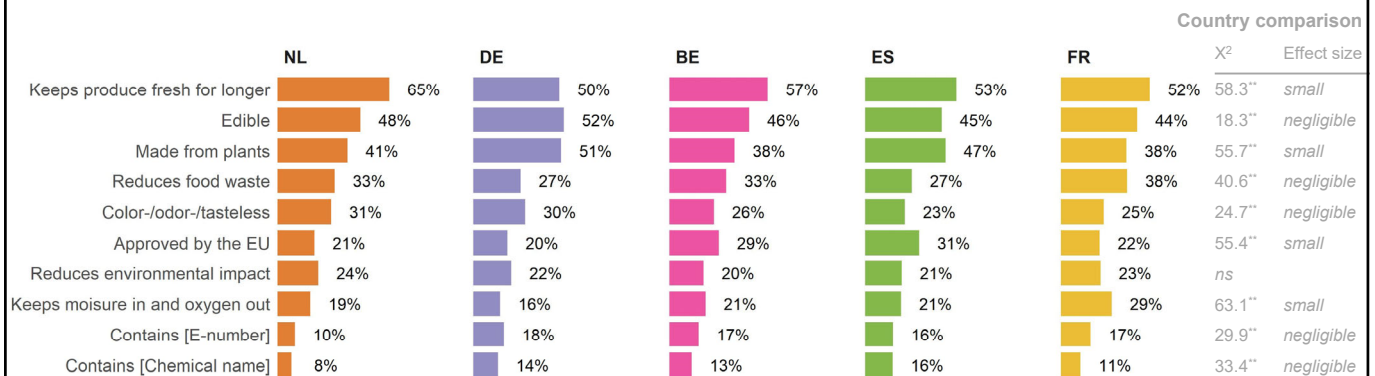
Q13. Preferred statements (each respondent selected three)



- 'Keeps produce fresh for longer', 'edible' and 'made from plants' are selected most often
- Ingredient statements selected least often

38

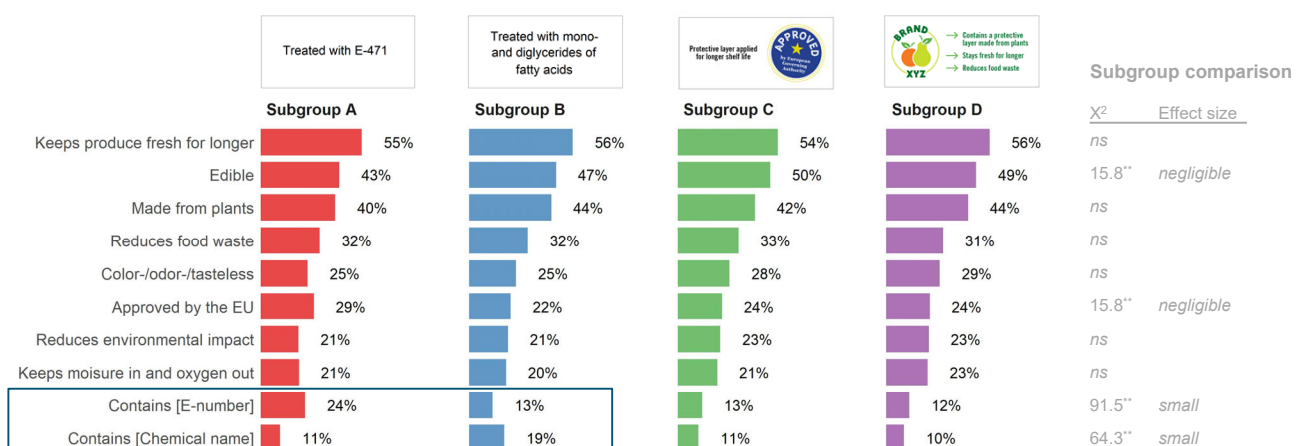
Q13. Preferred statements by country



- Same top 3 in all countries

- 'Keeps produce fresh for longer' selected relatively more often by Dutch consumers
- 'Made from plants' selected relatively more often by German consumers
- 'Approved by EU' selected relatively more often by Spanish and Belgian consumers
- 'Keep moisture in and oxygen out' selected relatively more often by French consumers

Q13. Preferred statements by subgroup

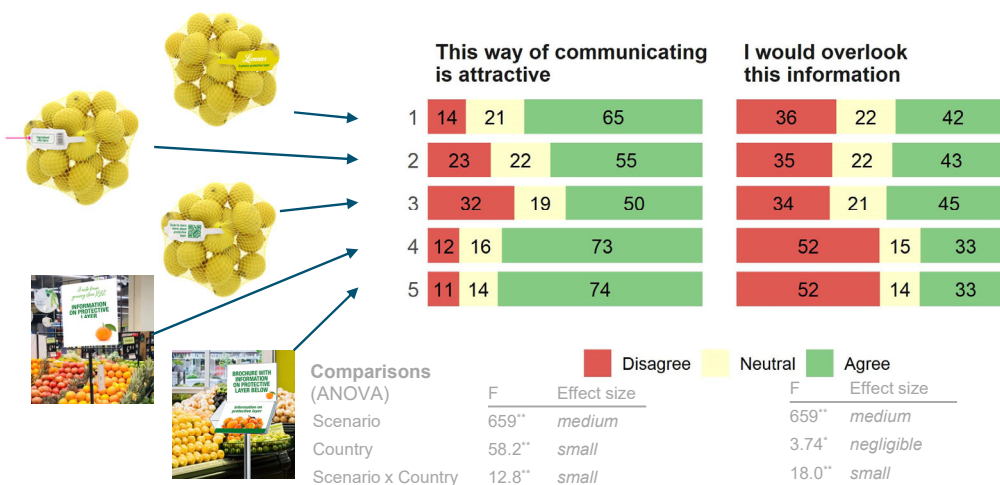


- Initial disclosure message induces small response bias: Ingredient statements are selected relatively more often if these were seen before

Preferred disclosure channels & trusted sources

41

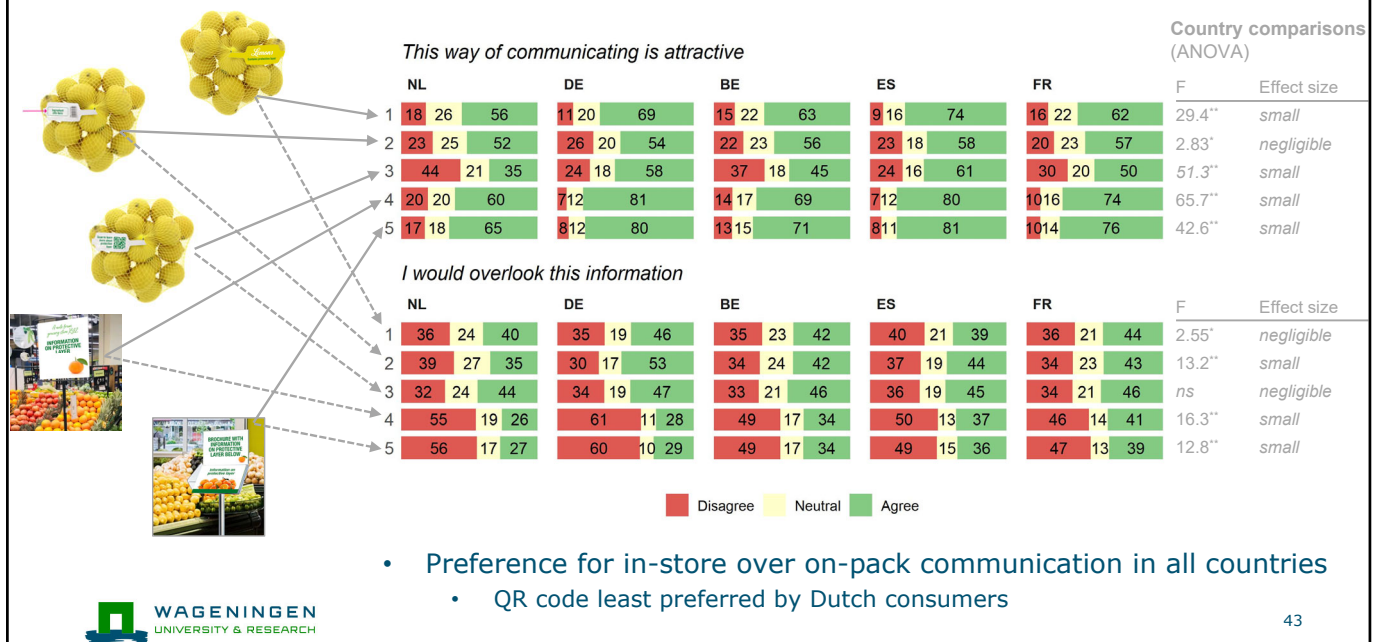
Q15. Preferred disclosure channels



- Preference for in-store communication (4-5)
 - Front-of-label (1) more attractive than back-of-label (2-3), but equally likely to be overlooked

42

Q15. Preferred disclosure channels by country



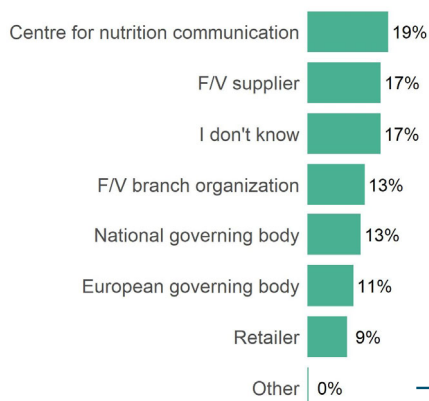
43

Q15. Pairwise scenario comparisons

						
Attractive	FULL SAMPLE	5.0 ^b	4.6 ^c	4.3 ^c	5.3 ^{a,b}	5.4 ^a
	NL	4.6 ^{a,b}	4.5 ^b	3.7 ^c	4.7 ^{a,b}	4.9 ^a
	DE	5.2 ^b	4.5 ^c	4.6 ^c	5.6 ^a	5.6 ^a
	BE	4.9 ^{a,b}	4.6 ^b	4.1 ^c	5.1 ^a	5.2 ^a
	ES	5.3 ^b	4.7 ^c	4.7 ^c	5.6 ^a	5.7 ^a
	FR	4.9 ^b	4.7 ^b	4.3 ^c	5.4 ^a	5.5 ^a
Overlook	FULL SAMPLE	4.1 ^a	4.1 ^a	4.2 ^a	3.4 ^b	3.4 ^b
	NL	4.0 ^a	3.9 ^a	4.2 ^a	3.3 ^b	3.3 ^b
	DE	4.2 ^a	4.5 ^a	4.2 ^a	3.1 ^b	3.1 ^b
	BE	4.1 ^a	4.1 ^a	4.3 ^a	3.6 ^b	3.5 ^b
	ES	3.9 ^{a,b}	4.1 ^a	4.1 ^a	3.6 ^b	3.6 ^b
	FR	4.1 ^{a,b}	4.1 ^{a,b}	4.2 ^a	3.7 ^{b,c}	3.7 ^c

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Q15_A. QR code: Expected source

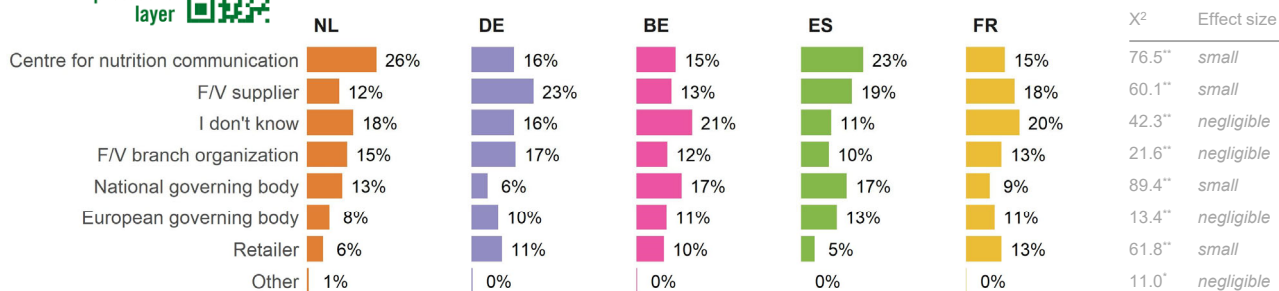


- Consumers have no obvious expectation about the information source
- Responses almost equally divided over response options

5 consumers mention "producer of the protective layer"

45

Q15_A. QR code: Expected source by country



Country comparison

X ²	Effect size
76.5**	small
60.1**	small
42.3**	negligible
21.6**	negligible
89.4**	small
13.4**	negligible
61.8**	small
11.0*	negligible

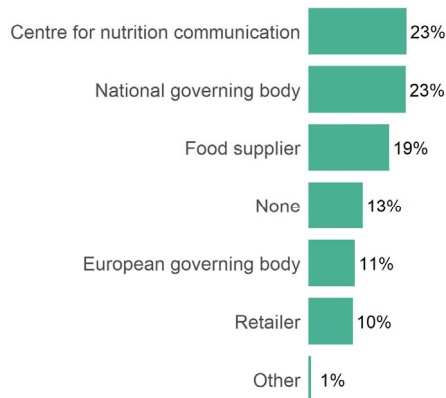
- No clear expected information source in any country
 - Dutch and Spanish consumers expect to be linked to a centre for nutrition communication relatively more often, and to the retailer relatively less often
 - Relatively more German consumers expect to be linked to the F/V supplier
 - Relatively more Belgian and Spanish consumers expect a national governing body

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Q15_B. QR code: Desired source



Note: answer categories highly similar but not identical to Q15_A



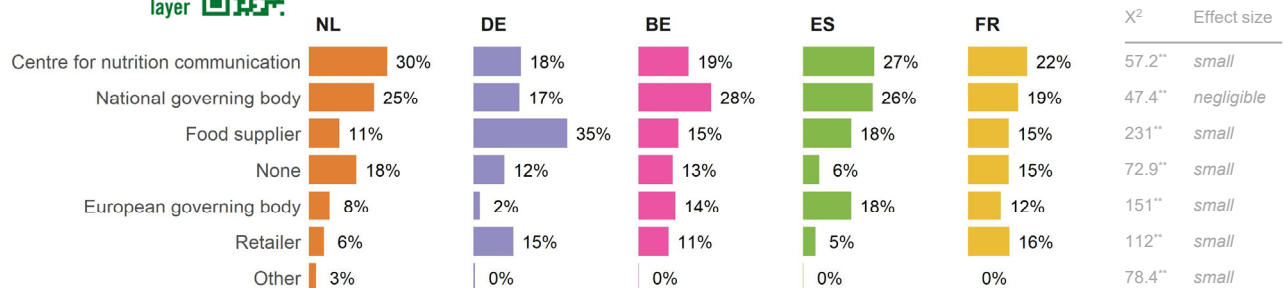
- Slight preference for Centre for nutrition communication and national governing body (both selected by 23% of respondents)
- National governing body is a desired more often than an expected source

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Q15_B. QR code: Desired source *by country*



Country comparison

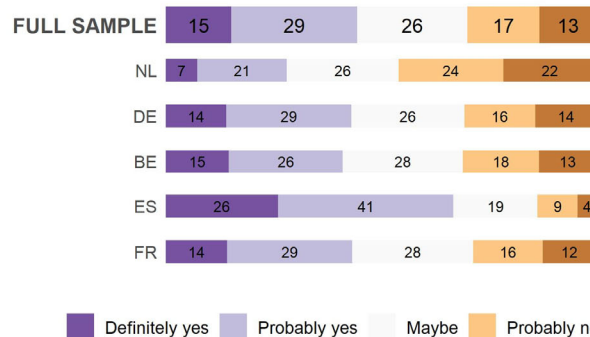


- Variation in desired sources in all countries
 - Centre for nutrition communication desired more by Dutch and Spanish consumers
 - Food supplier desired more by German consumers
 - Retailer desired more by French and German consumers
 - European governing body desired more by Spanish (/Belgian) consumers

48

Q15_C. Would you scan the QR code?

Scan to learn more about protective layer



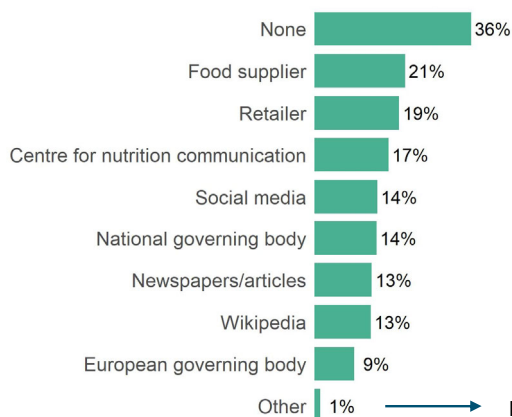
Country comparison (Chi-squared)

$\chi^2(16) = 359^{**}$
Effect size: small

- Overall, there are more consumers who would scan the QR code (44%) than there are consumers who would not (30%)
 - Spanish consumers most likely to scan the QR code, Dutch consumers least likely (in line with general response pattern)

Q16. Consulted food information sources in the past year (multiple answers possible)

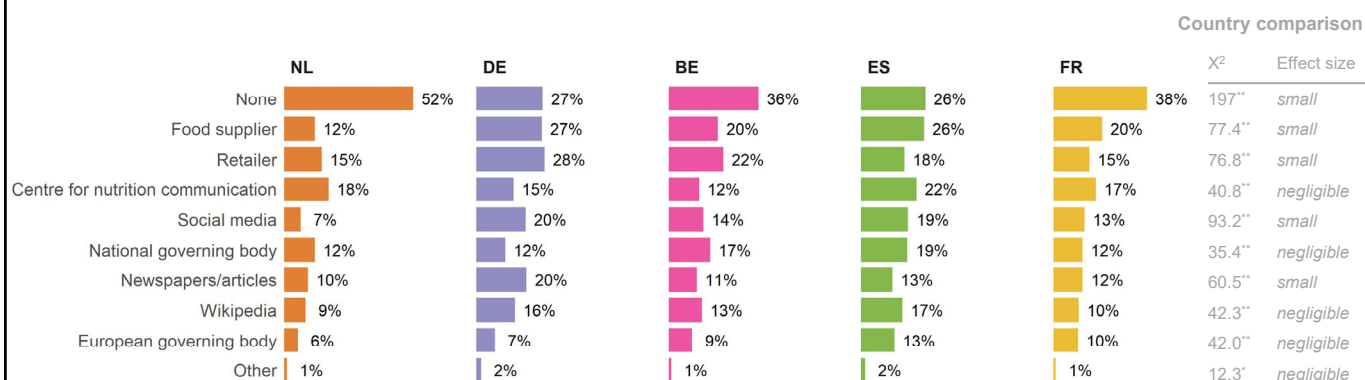
Which sources?



- Over a third of consumers (36%) has not consulted any food information source in the past year
- No clearly preferred source

Most frequently mentioned: Google (N=23), Yuka.io (N=9)

Q16. Consulted food information sources per country

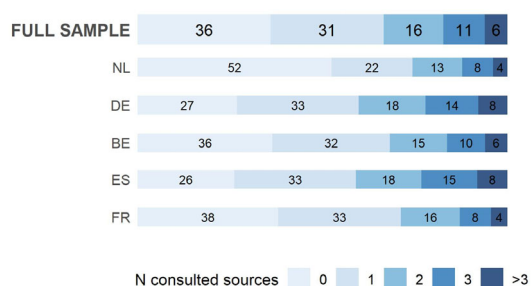


- No clearly preferred source in any country
- Dutch consumers least likely to consult any food information source, Spanish and German consumers most likely

51

Q16. Consulted food information sources in the past year (multiple answers possible)

Number of consulted sources per respondent



Country comparison
(Chi-squared)

X² (16) 228**

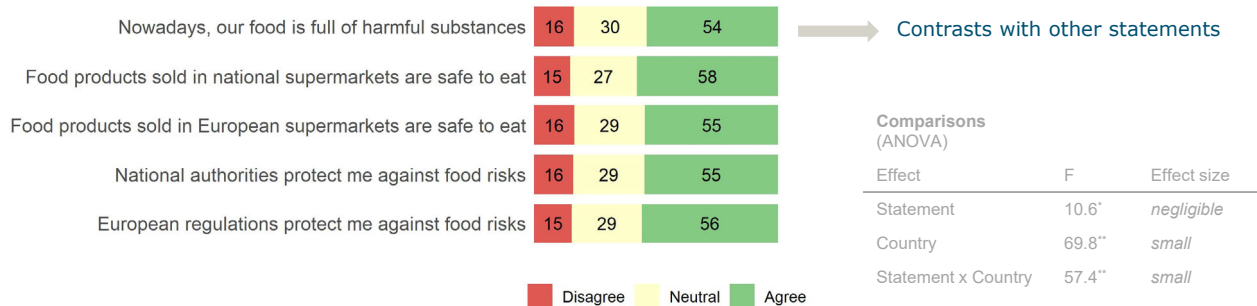
Effect size small

Majority of consumers (67%) has not consulted more than one source

- Dutch consumers consulted least sources, Spanish and German consumers most

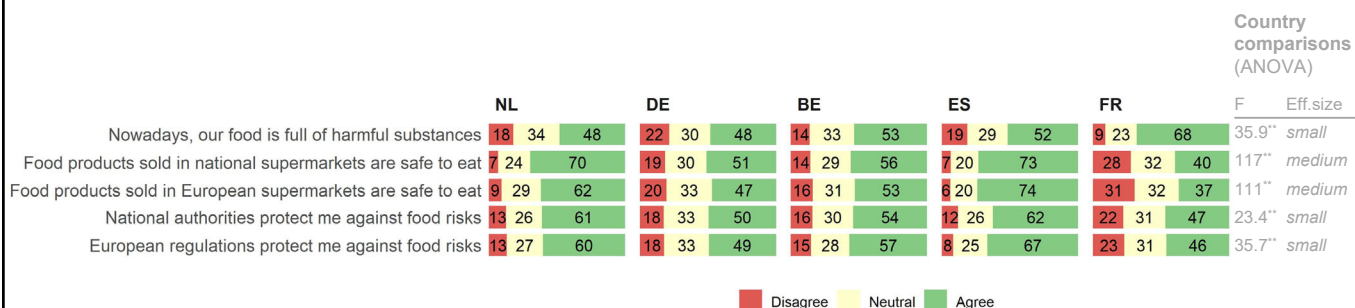
52

Q17. Consumer trust



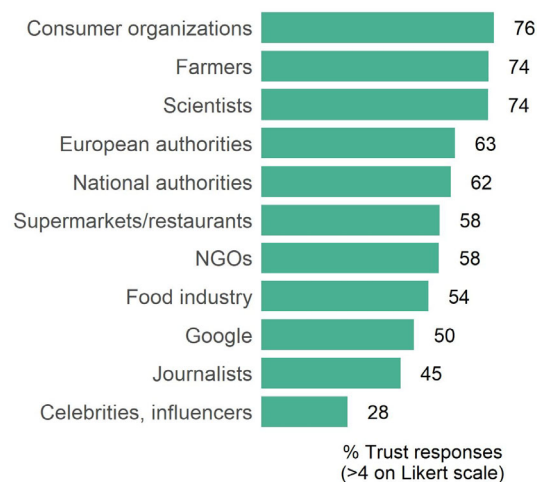
- Majority of consumers expresses trust in food safety, despite scepticism (statement 1)

Q17. Consumer trust by country



- Consumer trust overall highest in Spain (conform general response pattern), followed by the Netherlands
 - French consumers have overall lower trust, especially in supermarket foods
 - Dutch consumers have (somewhat) more trust in national vs. European supermarket foods
 - Spanish consumers have (somewhat) more trust in European vs. national authorities

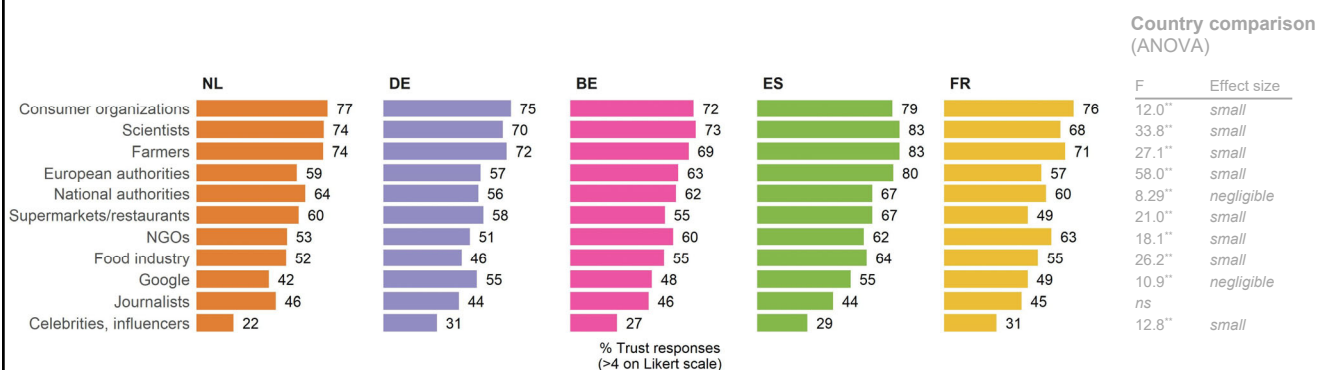
Q18. Trusted sources



- Consumers have most trust in consumer organizations, farmers and scientists
- Consumers have least trust in celebrities and influencers
- Less than half of consumers has trust in journalists

55

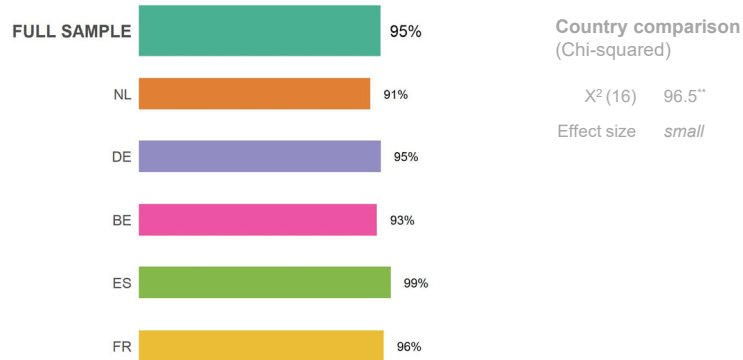
Q18. Trusted sources by country



- Similar pattern across countries
 - Spanish consumers have highest trust overall (general response bias), and relatively more trust in European vs. national authorities
 - French consumers have relatively low trust in supermarkets/restaurants

56

Q19. Disclosure needs if approved by EU



Clear need for transparency in all countries

- For Dutch consumers, disclosure needs are relatively lowest, but still over 90% of consumers believes the presence of a protective layer on fresh F/V should be disclosed

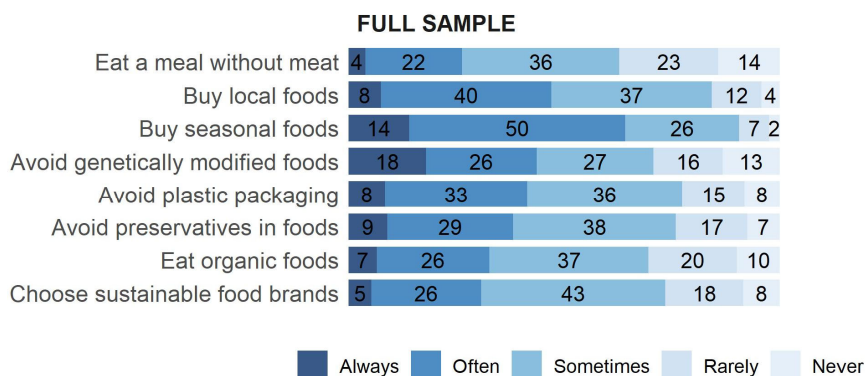
Background questions

Food and F/V purchase behaviour

	FULL SAMPLE	NL	DE	BE	ES	FR	Comparison	Effect size
S1. Who is the primary decision maker of grocery purchases in your household?								
<i>N (%) respondents</i>							$\chi^2(8)=44.5^{**}$	<i>negligible</i>
I do all the grocery shopping	2883 (57)	594 (59)	559 (56)	585 (58)	505 (50)	640 (63)		
I do most of the grocery shopping	1053 (21)	176 (18)	224 (22)	213 (21)	260 (26)	180 (18)		
I share in the grocery shopping responsibility	1099 (22)	231 (23)	220 (22)	219 (22)	236 (24)	193 (19)		
Q1. How often do you purchase fresh fruits and vegetables?								
<i>N (%) respondents</i>							$\chi^2(16)=179^{**}$	<i>small</i>
4 or more times a week	816 (16)	157 (16)	144 (14)	147 (14)	240 (24)	128 (13)		
2 to 3 times a week	2232 (44)	480 (48)	520 (52)	390 (38)	476 (48)	366 (36)		
once a week	1726 (34)	331 (33)	297 (30)	406 (40)	248 (25)	444 (44)		
every 2 weeks	170 (3)	27 (3)	24 (2)	48 (5)	26 (3)	45 (4)		
once a month or less	91 (2)	6 (1)	18 (2)	26 (3)	11 (1)	30 (3)		

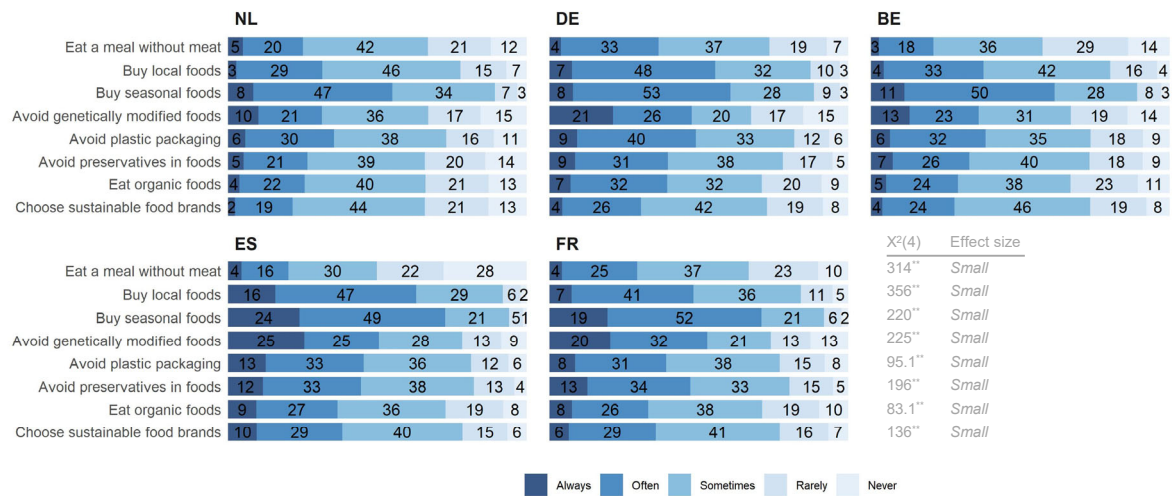
- Majority of consumers solely responsible for groceries
- Majority of consumers purchases F/V one to three times per week
 - Percentage of weekly F/V purchasers relatively high in Belgium and France
 - Percentage of frequent F/V purchasers relatively high in Spain

Food-consciousness



- Buying local and seasonal foods most common food-conscious behaviours

Food consciousness per country

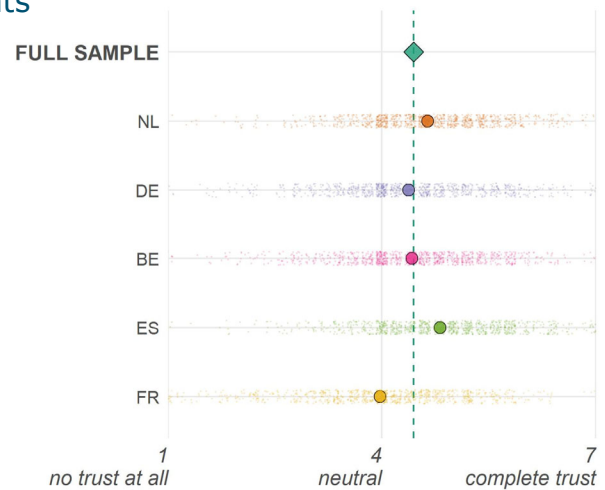


Buying local and seasonal foods most common in all countries

Extra analysis: Correlations with consumer trust

Consumer trust (general)

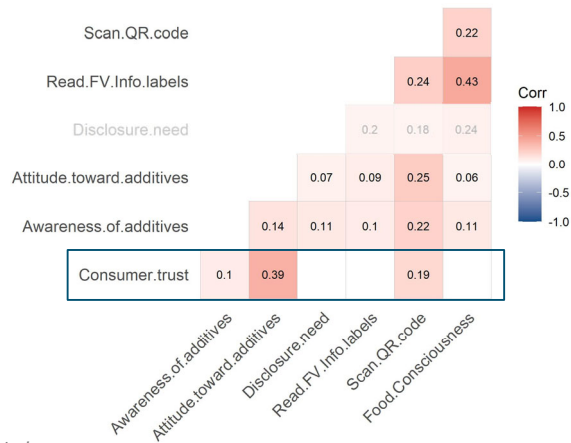
Responses averaged across statements
(first item recoded; Cronbach's $\alpha=0.80$)



Correlations

- Consumer trust (general) correlated with
 - Awareness (perceived likelihood) of food additive use (Q8)
 - Attitudes toward food additive use (Q9) *averaged across items; Cronbach's $\alpha = 0.93$*
 - Disclosure needs (Q10)
 - Likelihood to read information labels on F/V (Q3)
 - Likelihood to scan QR code (Q15_C)
 - Food consciousness (Q20) *averaged across items; Cronbach's $\alpha = 0.78$*
- Spearman correlations

Additional analyses: Correlations with consumer trust



Effect sizes
 <0.1 negligible
 0.1 – 0.3 small
 0.3 – 0.5 moderate
 >0.5 large



- Moderate positive relation with attitudes
 - Consumers with more trust are (somewhat) more positive (/less concerned) about post-harvest additives
- No relation with disclosure needs
 - Strong need for transparency regardless of trust
- Weak positive relation with likelihood to scan QR code
 - Consumers with more trust are (somewhat) more likely to look up more information about the about protective layer: curiosity rather than distrust

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



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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.

