Impact of consumers' understanding of date labelling on food waste behaviour

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Abstract

This research analyses the impact that the level of understanding of date marking (among other influences) has on the food waste behaviour of consumers in the European Union focusing on a comparison between European Union countries. The data were extracted from the Dataset Flash Eurobarometer 425: Food waste and date marking (European Commission, 2015) and structural equation models to estimate the strength of these influences on behaviour. The results show that socio-demographics (age; education; occupation); behavioural control (perceptions regarding the need for better and clearer information about 'best before' and 'use by' date labelling on food products; frequency of checking date labels when shopping and preparing meals); and understanding of 'best before' and 'use by' labels have significant effects on behaviours related to lower food waste (use of senses instead of labels to decide whether to eat or throw away food e.g. non-perishable foods from own kitchen cupboard with no 'best before' date indicated on the label which were not bought recently; or food products which must be used within a certain number of days after opening and are past that; and the need for 'best before' dates on non-perishable foods, such as rice, pasta, coffee or tea). The stated understanding of date labelling is a key influence in all models and explains a consistent fifth (ceteris paribus) of the variance in behaviour.

Keywords: date labelling, food waste behaviour, structural equation modelling, European consumers

MSC codes: 91C99, 62H99

Conflict of Interest: The authors declare that they have no conflict of interest.

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Abstract

This research analyses the impact that the level of understanding of date marking (among other influences) has on the food waste behaviour of consumers in the European Union focusing on a comparison between European Union countries. The data were extracted from the Dataset Flash Eurobarometer 425: Food waste and date marking (European Commission, 2015) and structural equation models to estimate the strength of these influences on behaviour. The results show that socio-demographics (age; education; occupation); behavioural control (perceptions regarding the need for better and clearer information about 'best before' and 'use by' date labelling on food products; frequency of checking date labels when shopping and preparing meals); and understanding of 'best before' and 'use by' labels have significant effects on behaviours related to lower food waste (use of senses instead of labels to decide whether to eat or throw away food e.g. non-perishable foods from own kitchen cupboard with no 'best before' date indicated on the label which were not bought recently; or food products which must be used within a certain number of days after opening and are past that; and the need for 'best before' dates on non-perishable foods, such as rice, pasta, coffee or tea). The stated understanding of date labelling is a key influence in all models and explains a consistent fifth (ceteris paribus) of the variance in behaviour.

1. Introduction

Currently, 88 million tonnes of food are wasted in the European Union (EU-28) every year. This represents 173 kg per capita or 20 per cent of the EU's annual food production, and is projected to increase by 40 per cent by 2020 if no action is taken. Over 50 per cent of this food waste occurs at the household level (Stenmarck et al., 2016), a pattern seen across many developed regions (Gustavsson et al., 2011; Buzby et al., 2016).

The causes of food waste are complex and operate at a number of inter-related levels in the supply chain (High Level Panel of Experts (HLPE), 2014; Mena et al., 2014; Parfitt et al., 2010). Actions taken upstream in the food supply chain may affect the amount of waste produced downstream,

including households. For example, manufacturers in conjunction with retailers may set expiry dates, in particular best before dates, very conservatively (Priefer et al., 2016). Evidence suggests that even small increases in shelf life could result in a significant reduction in food waste at the household level (WRAP, 2015, 2013b). There are therefore valid questions about the extent of responsibility that households have for the food waste they produce or efficacy in reducing it. In particular, recent sociological research has highlighted how food waste is simply a consequence of everyday life and the constraints faced by modern households (Evans, 2012; 2011). However, other research suggests that there are inter-related behaviours, over which households have control that are associated with lower levels of food waste (WRAP, 2013a; Quested et al., 2013). As regards the household behaviour towards food waste, the Waste and Resources Action Programme (WRAP) monitors nine key behaviours on a regular basis which are believed to lead to lower levels of household food waste: planning meals in advance, checking levels of food in cupboards prior to shopping, making a shopping list, storing meat and cheese in appropriate packaging, storing all fruit (except bananas) in the fridge, using the freezer to extend the shelf-life of food, portioning rice and pasta, using up leftovers, and using date labels on food (Quested et al., 2013). Different types of households cite different reasons for wasting food; for example young professionals tend not to plan meals, whereas young families report being sensitive to dates and cook too much (WRAP, 2007). More evidence is required to understand the antecedents of these behaviours and therefore how behaviour might be changed. This research will focus on one of these behaviours, the use of date labels on food.

The European Union (EU) labelling requirements for food products are currently specified in Regulation (EU) No 1169/2011 (European Union, 2011). This regulation contains the list of mandatory food information to be included in all food labels from December 2016 onwards. The list includes the date of minimum durability or the 'use by' date. The regulation also specifies the way it shall be expressed as well as for which products it is not required such as fresh fruit, wines, alcoholic beverages, salt, sugar, etc. Most pre-packed food requires the date of minimum durability or 'best before' date and only for the case of food products with potential microbiological hazards is the 'use by' date required. Therefore, after the 'use by' date a food product shall be deemed to be unsafe in accordance with Article 14(2) to (5) of Regulation (EC) No 178/2002. Dissimilarly, the 'best before' date refers to quality issues distant to food safety ones.

A number of authors reported the current food date labelling system as a barrier to the management of food from both food waste and food safety perspectives (Priefer et al., 2016; Broad Leib et al., 2016; Rahelu, 2009; Food Standards Agency (FSA), 2016; TNS European Behaviour Studies Consortium (EBSC), 2014). Most recently, evidence from the USA indicates that simplifying and clarifying expiry date labelling could be one of the most cost-effective ways to reduce food waste (Broad Leib et al., 2016).

This research seeks to build on these findings by analysing the extent to which knowledge of the difference between 'best before' and 'use by' dates and the frequency of date label checking affect the use of date labels on food (such as willingness to eat non-perishable foods when a best-before date is missing) across socio-demographic groups and across the Western, Eastern and Mediterranean EU-28. The reason for estimating the model in these three regions is due to the fact that, while date labelling in EU countries follows food Regulation (EU) no. 1169/2011 of the European Parliament and Council, each country transitions from a different regime and the speed and type of rollout of the legislation across countries may affect the level of date labelling knowledge of their citizens. The EBSC eight-country study (2014) found Finland and UK respondents to be more knowledgeable than those from other countries. However, no clear north-south patterns were identified. Jörissen et al. (2015) compare food waste behaviours in Italy and Germany and conclude that attitudes towards the handling of and regard for food are more influenced by social class and educational level than by nationality. In terms of linking date labelling knowledge and behaviour to food waste prevention, there are significant differences across the EU-28 (European Environment Agency, 2015). As highlighted through this research, the relationship between knowledge and behaviour is affected by a range of attitudinal and social factors, and is linked to the different ways of shopping and cooking. The way country effects play out for food waste needs to be better understood (EBSC, 2014) and this research attempts to add to the current evidence.

The research is structured in five sections: subsequent to the introduction, the next section describes the research hypotheses and the conceptual model, followed by the presentation of data and methods, discussion of results and conclusions.

2. Research hypotheses and conceptual model

To understand the influence of date label understanding on date label usage, a conceptual model (Fig. 1) was developed to describe part of the household reasoning process that supports food waste generation. Namely, it attempts to identify the influence of date marking in the decision-making process concerning food waste generation taking into account socio-demographic characteristics, understanding of date labelling and behavioural control aspects such as the perceived need for clearer information about date labelling and frequency of checking date labels.
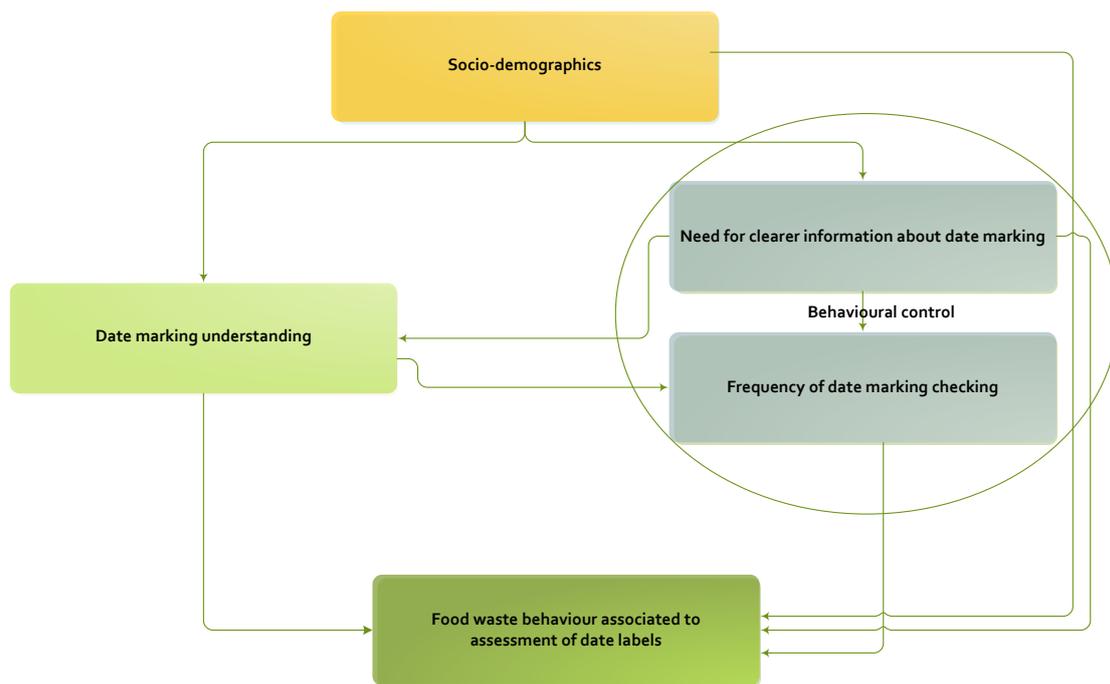
Figure 1. Conceptual model

The conceptual model is consistent with the following research hypotheses based on findings from the food waste literature:

Hypothesis 1: *Socio-demographics (age, education and occupation) have an influence on (a) date marking understanding; (b) behavioural control regarding the appropriate use of date marking; and (c) behaviours associated with lower food waste.*

A number of studies have indicated that socio-demographic characteristics have an influence on knowledge and use of date labels (WRAP, 2011; Broad Leib et al., 2016; EBSC, 2014; van Boxstael et al., 2014). WRAP (2011) found that older respondents paid less attention to date labels than younger respondents in the UK. This may be related to the fact that older people have learnt to trust and use

their senses instead of labels better than younger generations; however it may appear to be in contradiction with the established evidence regarding the stronger food safety perceptions of the adult consumers as compared to the younger ones (Sanlier, 2009). Younger respondents are found to be more likely to misinterpret 'best before' date labels – believing them to be indicators of food safety and using them as a risk indicator - and thus more likely to discard food past the date on the label (Broad Leib et al., 2016). On the contrary, older respondents were more likely to misinterpret 'use by' dates – believing them to be indicators of food quality, and potentially exposing themselves to a food safety risk. This is consistent with results of other studies which found a negative relationship between the age of consumers and the amount of food waste generated (Quested et al., 2013; Van Garde and Woodburn, 1987; Watson and Meah, 2012, Visschers et al., 2016). A recent study of eight European countries found that young male consumers had the best knowledge on these issues, even though overall 'best before' dates were misinterpreted more often than not by all categories of consumers (EBSC, 2014). A Belgian study found that more than two thirds of respondents knew the difference between 'best before' and 'use by' (Van Boxstael et al., 2014). They found that older respondents (65+) were more familiar with date labelling overall, and in contrast to the WRAP (2011) study, 'best before' was better understood by younger respondents whereas 'use by' was best understood among the older respondents. However, it should be noted that the Belgian study only asked respondents to indicate their subjective knowledge with the question *"Do you know the labels 'use by' and 'best before'?"* The difference between the results of the above-mentioned studies indicates that, although socio-demographics seem to have an influence on the knowledge of and use of date labelling, there is mixed evidence about the sign of their effects.

Employment status is another socio-demographic factor found to have an impact on household food waste (WRAP, 2014). Specifically, those households where the main earner was retired were less likely to throw food away when past the date on the packaging. While there is a relationship between age and retirement, employment status still had a statistically significant effect when age was controlled for.

Gender has not been found to have a significant effect on consumers' knowledge of date labels (Van Boxstael et al., 2014; WRAP, 2011), though women were shown to be marginally more aware that 'use by' marking had food safety implications (no statistical significance was reported) (WRAP, 2011). However, in wider food waste studies some gender differences have been observed. For example, WRAP (2014) found that more avoidable food and drink waste was reported by women in the kitchen

diary measures of food waste. Mallinson et al. (2016) also found that one of the clusters ("Kitchen Evaders") reporting high levels of food waste included a high proportion of young women. This finding was supported by Visschers et al. (2015); however here the composition of the female respondent's households tended to be the driving factor. They concluded in fact that specific household situations could override strong intentions, attitudes and norms to reduce food waste.

The "Kitchen Evaders" cluster of Mallinson et al. (2016) was also the cluster with the lowest reported level of education, with the majority not having studied beyond A-level. Higher levels of education seem to be associated with waste of certain types of foods, e.g. fruits and vegetables (Visschers et al., 2015). However, it is not clear to what extent this might reflect differences in purchasing patterns.

Hypothesis 2: Date labelling understanding has an influence on frequency of use of date labels and behaviours associated with lower food waste.

Adding to the effect of socio-demographic factors on both knowledge/understanding of date labels and use of date labels, it was also hypothesised that understanding of date marking influences the frequency of use of date labels and other behaviours associated with lower food waste.

Both WRAP (2011) and van Boxstael et al. (2014) found that understanding (objective or subjective knowledge, respectively) of date labelling does not necessarily result in correct or more frequent usage of date labelling. For example, van Boxstael et al. (2014) found that only 49.3 per cent of their respondents took date labels into account when deciding whether or not to eat a food product compared to the 69.6 per cent who reported knowing the difference between date labels. They also found significant variation by product type in the date label usage to assess edibility. Similarly, Rahelu (2009) reported that consumers do not treat different food groups in the same way. In a similar vein, WRAP (2011) found differences in the use of date labels by product type; however their analysis outlined a complex array of factors such as attitudes, values, habits, risk perception and trust, which potentially affected the relationship between knowledge and behaviour. Factors such as trust in or perceptions of labels (Broad Leib et al., 2016) as well as the role of habit and repeat purchasing (FSA 2016) are important. This may mean that, while consumers may know the difference between date labels, they might not consider it necessary to check the date label either at the point of purchase or at home since they develop a sense of how long the product lasts.

Outside the food waste literature there have been a number of studies across environmental (Kaiser and Fuhrer, 2003; Redman and Redman, 2014; Peschel et al., 2016), health (Wardle et al., 2000; Worsley,

2002; Grunert et al., 2010) and food safety (Meysenburg et al., 2014) fields that have shown that objective or declarative knowledge is a necessary but not sufficient condition for behaviour. For example Peschel et al. (2016) found that, while less knowledge might make one less likely to make an environmentally friendly choice, better knowledge might not make one significantly more likely to choose it either as people tend to balance between factors such as price and the environment.

Kaiser and Fuhrer (2003) and Redman and Redman (2014) also found limited impact of objective or declarative knowledge alone and argued that it needed to converge with other domains of knowledge (procedural, social, and effectiveness) in order to affect behaviour.

A Food Standards Agency (FSA) (2016) survey on food labelling issues reported that consumers considered retail food labelling information in a 'needs-based behaviour' and that the most frequently checked information when purchasing food was the 'use by' or 'best before' information. However, many authors reported that the current food date labelling system with different types of date marking can generate confusion among consumers (Rahelu, 2009; FSA, 2009; NRDC, 2013; FSA, 2016; Priefer et al., 2016). The FSA (2016) report also noted that respondents stated internal conflicts between not wishing to take health risks by ignoring date labels and not wanting to waste food.

Hypothesis 3: Perceived behavioural control (need for clearer information on date labelling and frequency of checking date labels) has an effect on behaviours associated with lower food waste.

According to Ajzen and Madden (1986) and numerous other authors, perceived behavioural control will influence behaviour directly and/or indirectly through behavioural intentions. Visschers et al. (2016) emphasised the relevance of perceived behavioural control on food waste behaviour. They found that perceived behavioural control was one of the most important predictors of the amount of food waste per household member. However, evidence from WRAP (2007, 2011) suggested that frequency of use or sensitivity to date labels was not a straightforward way of identifying low food wasters from high food wasters. This is because there seem to be behaviours associated with high date sensitivity (e.g., food planning and shopping) that combined may result in lower waste; equally there are behaviours associated with low date sensitivity or frequency of checking such as a willingness to eat leftovers or food past its date, which may also be associated with lower food waste (WRAP 2011). Similarly, Visschers et al. (2016) found that, with regard to consuming leftovers, consumers with more positive attitudes and norms regarding food waste reduction and with lower risk perceptions about

consuming leftovers showed a higher intention to reduce food waste as well as reporting less food waste.

The behaviours related to lower food waste measured by the Flash Eurobarometer 425 (European Commission, 2015) are about consuming food after or without knowing the 'best before' date or eating products after they have been open for more than the recommended number of days. It was therefore hypothesised that those who check dates most frequently, i.e., appear to be more sensitive to dates, would be less likely to exhibit the behaviours analysed.

3. Data and methods

3.1. Data

The data used in this research were extracted from the Dataset Flash Eurobarometer 425: Food waste and date marking (European Commission, 2015). The Eurobarometer survey was carried out by the TNS Opinion & Social through face-to-face interviews of citizens in the 28 Member States of the European Union, with an average sample size of 950 observations.

The variables included in the analysis are:

− socio-demographic variables (age, education, occupation);

− understanding of 'best before' and 'use by' labels on food products;

− perceived need for better and clearer information on the meaning of 'best before' and 'use by' dates indicated on food labels;

− frequency of checking the 'use by' or 'best before' dates on food labels when shopping and preparing meals;

− food waste behaviour, i.e. use of senses instead of labels to decide whether to eat or throw away food (e.g. non-perishable foods from own kitchen cupboard with no 'best before' date indicated on the label which were not bought recently; or food products which must be used within a certain number of days after opening and are past that); and stated need for 'best before' dates on non-perishable foods, such as rice, pasta, coffee or tea.

Table 1 presents a description of the latent variables and the corresponding indicators included in the SEM models.

Table 1. Description of latent variables and their corresponding indicators

Latent variables	Indicators (statements)	Values and labels
age	Age	15-24/ 25-34/ 35-44/ 45-54/ 55-64/ 65 and older
education	Education	no full time education/ still studying/ up to 15/ 16-19/ 20 years and older
occupation	Occupation	not working/ manual workers/ employees/ self-employed
label	What do you think 'best before'/'use by' on a food product actually means? correct answer for 'best before' is 'The food can be consumed after this date, but it may no longer be at its best quality'/correct answer for 'use by' is 'The food will be safe to eat up to this date, but should not be eaten past this date'	no correct answer/ one correct answer/ two correct answers
help	Do you think better and clearer information on the dates indicated on food labels would help you to waste less food at home? Do you think better and clearer information on food product labels would help you to waste less food at home?	otherwise/ yes
behavfr	How often, if at all, do you look at 'use by' or 'best before' dates on food labels when shopping and preparing meals?	never/ rarely/ sometimes/ often/ always
behav	If you found a package of spaghetti in your kitchen cupboard with no 'best before' date indicated on the label and you could not remember when you bought it, what would you do?	otherwise/ 'use it anyway' or 'use it if the product looks all right and the packaging is not damaged'
	Some food labels indicate that, once opened, a product must be used within a certain number of days. If you have not used up the product within the time indicated on the label, what do you usually do?	otherwise/ 'use it if the product looks all right and the packaging is not damaged'
	In future, if you no longer found 'best before' dates on other non-perishable foods, such as rice, pasta, coffee or tea, how would you respond?	otherwise/ 'you do not need this information'

Figure 2 shows that more than half of the consumers interviewed in each of the three groups always look at 'use by' or 'best before' dates on food labels when shopping and preparing meals, and a fifth up to a quarter of consumers check dates on a frequent basis. These results are in line with those reported by the FSA (2016) survey.
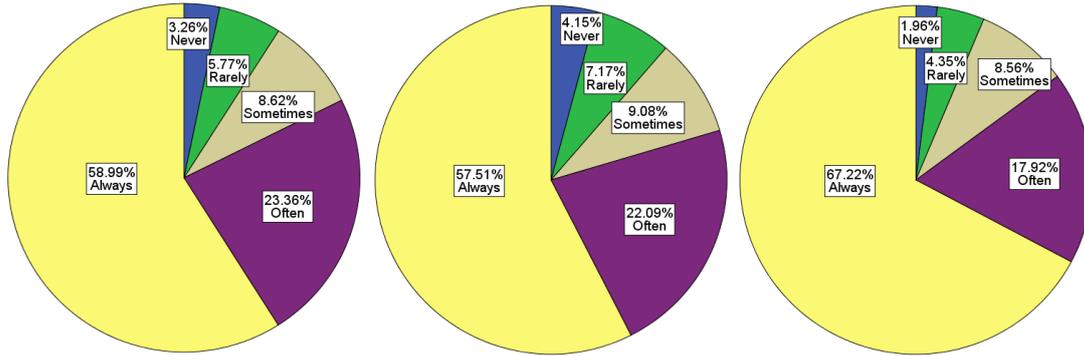
Figure 2 a,b,c. How often, if at all, do you look at 'use by' or 'best before' dates on food labels when shopping and preparing meals? Responses for Western, Eastern and Mediterranean subsamples

Regarding behaviours, Figure 3 shows that in the absence of date labels more than 60 percent of respondents in each group feel confident to use their own senses to assess the safety of the product before consuming it, with Western Europeans being the most, and Mediterranean consumers the least confident.
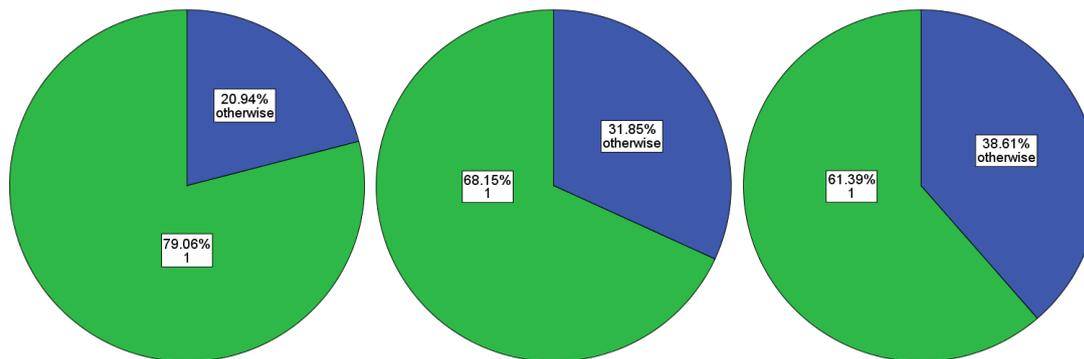
Figure 3 a,b,c. If you found a package of spaghetti in your kitchen cupboard with no 'best before' date indicated on the label and you could not remember when you bought it, what would you do? ('use it anyway' or 'use it if the product looks all right and the packaging is not damaged'). Responses for Western, Eastern and Mediterranean subsamples

However, in the presence of date labels and outside the period of time during which the product must be used after opening, a lower percentage of consumers choose to consume it (Figure 4).

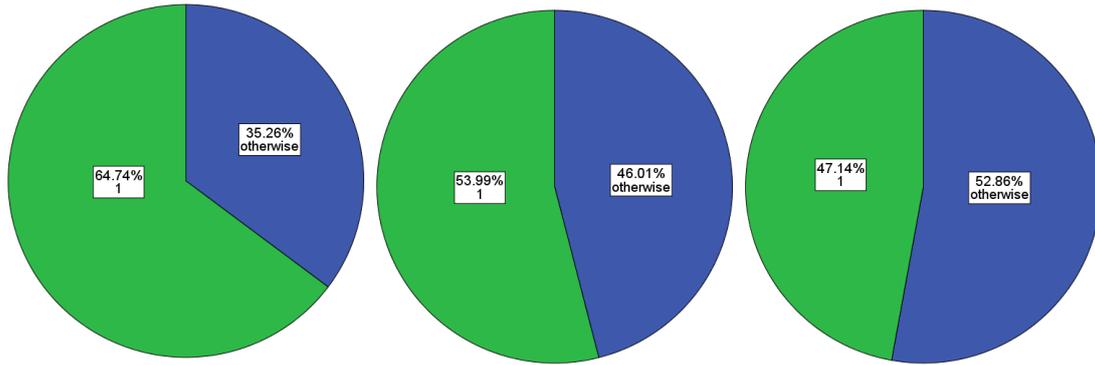Figure 4 a,b,c. Some food labels indicate that, once opened, a product must be used within a certain number of days. If you have not used up the product within the time indicated on the label, what do you usually do? ('use it if the product looks all right and the packaging is not damaged'). Responses for Western, Eastern and Mediterranean subsamples.

The same ranking as in Figure 3 and similar differences between the three groups apply. This may indicate that Mediterranean and Eastern European consumers may be more risk-averse to food safety issues and/or less sensitive to food waste than Western Europeans.

Figure 5 shows that Mediterranean and Eastern European consumers have a stronger need for date labelling information than Western Europeans in order to perform their food consumption decisions (the same ranking as for the previous two behaviours applies; however a much higher difference is shown between the groups).

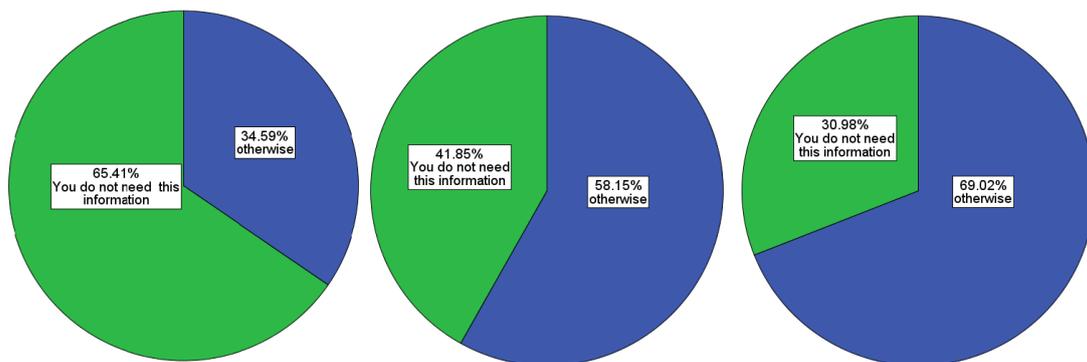Figure 5 a,b,c. In future, if you no longer found 'best before' dates on other non-perishable foods, such as rice, pasta, coffee or tea, how would you respond? Responses for Western, Eastern and Mediterranean subsamples

The aforementioned statistics may indicate a lower tendency to generating food waste as a result of date labelling evaluation in Western Europe as compared to Eastern and Mediterranean Europe.

3.2. **Methods**

Structural equation models (SEM) with observed and latent variables were used to estimate the influence of these determinants on stated food waste behaviour in three groups of countries – Western Europe (France, Belgium, Netherlands, Germany, Luxemburg, Denmark, Ireland, Great Britain, Finland, Sweden, Austria), Eastern Europe (Czech Rep, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, Bulgaria, Romania, Croatia) and Mediterranean Europe (Italy, Greece, Spain, Portugal, Cyprus, Malta).

As each variable might influence behaviour and intentions both directly and indirectly (through their effect on other variables in the model, which subsequently directly influence behaviour), the variance explained by the model is higher than when other methods, e.g., regression analysis, are used.

The model consists of two parts: the measurement model (which stipulates the relationships between the latent variables and their component indicators), and the structural model (which describes the causal relationships between the latent variables). The model is defined by the following system of three equations in matrix terms (Jöreskog and Sörbom 2007):

The structural equation model: $\eta = B\eta + \Gamma\xi + \zeta$

The measurement model for y: $y = \Lambda_y\eta + \varepsilon$

The measurement model for x: $x = \Lambda_x\xi + \delta$

where: η is an m*1 random vector of endogenous latent variables; ξ is an n*1 random vector of exogenous latent variables; B is an m*m matrix of coefficients of the η variables in the structural model; Γ is an m*n matrix of coefficients of the ξ variables in the structural model; ζ is an m*1 vector of equation errors (random disturbances) in the structural model; y is a p*1 vector of endogenous variables; x is a q*1 vector of predictors or exogenous variables; Λ_y is a p*m matrix of coefficients of the regression of y on η; Λ_x is a q*n matrix of coefficients of the regression of x on ξ; ε is a p*1 vector of measurement errors in y; and δ is a q*1 vector of measurement errors in x.

The models were estimated using the Diagonally Weighted Least Squares (DWLS) method and the statistical package Lisrel 8.80 (Jöreskog and Sörbom 2007). We combine Prelis to calculate the asymptotic covariance matrix (Muthén 1984; Bollen 1989) and Lisrel to compute test statistics for the estimation of the significance of causal relationships (Jöreskog and Sörbom 2007). The DWLS

estimation method is consistent with the types of variables included in the model (ordinal and categorical) and the deviation from normality in these variables (Finney and DiStefano 2006). The models were validated using absolute (root mean square error of approximation and goodness of fit index), incremental (adjusted goodness of fit index, non-normed fit index, normed fit index, relative fit index, comparative fit index and incremental fit index) and parsimonious (normed chi-square) goodness of fit (GoF) indicators (Hair et al. 2006). An acceptable level of overall goodness-of-fit does not guarantee that all constructs meet the requirements for the measurement and structural models. The validity of the SEM was assessed in a two-step procedure: the measurement model and the structural model. Model selection was performed through a nested model approach, in which the number of constructs and indicators remained constant, but the number of estimated relationships was changed iteratively.

4. Results and discussion

As mentioned in the method description section, the first step of the analysis consisted of a measurement model where the indicators (11) presented in Table 1 form the latent variables (7). The main parameters to test for the robustness of the constructs, convergent validity and internal consistency (composite reliability, internal consistency reliability, extracted validity and discriminant validity) resulted in acceptable values for all constructs following Hair et al. (2006). In addition, the model meets the wider acceptance goodness-of-fit standards for the confirmatory model. Results of the measurement model are not reported due to length limitations.

The second step of the analysis consisted of the structural equation model. Instead of performing a multi-country analysis for the structural model, we grouped the 28 countries in the aforementioned three groups and then estimated SEMs for each group. The model explains 18, 15 and respectively 10 per cent of the variance in the behaviour associated to date labelling evaluation in the three models. The model has excellent fit according to the measures of absolute, incremental and parsimonious fit (Hair et al. 2006). The main goodness-of-fit (GoF) indicators (estimated and recommended values) for the estimated model are presented in Table 2.

Table 2. Goodness of fit indicators

GoF indicators	Estimated value			Recommended value
	West	East	Med	
Root Mean Square Error of Approximation (RMSEA)	0.033	0.032	0.021	0.00-0.10
Goodness of Fit Index (GFI)	1	1	1	0.90-1.00
Normed Fit Index (NFI)	0.98	0.98	0.99	0.90-1.00
Non-Normed Fit Index (NNFI)	0.97	0.97	0.99	0.90-1.00
Comparative Fit Index (CFI)	0.98	0.98	0.99	0.90-1.00
Incremental Fit Index (IFI)	0.98	0.98	0.99	0.90-1.00
Relative Fit Index (RFI)	0.97	0.97	0.98	0.90-1.00
Adjusted Goodness of Fit Index (AGFI)	0.99	0.99	1	0.90-1.00
Standardized Root Mean Square Residual (SRMR)	0.029	0.033	0.024	0.00-0.10

Additional testing of the appropriateness of the models was achieved by comparing each of the estimated models with three other models that acted as alternative explanations to the proposed models in a competing-model strategy using a nested model approach. The results across all types of goodness-of-fit measures favoured the estimated model in most cases. Therefore, the accuracy of the proposed models was confirmed and the competing models were discarded.
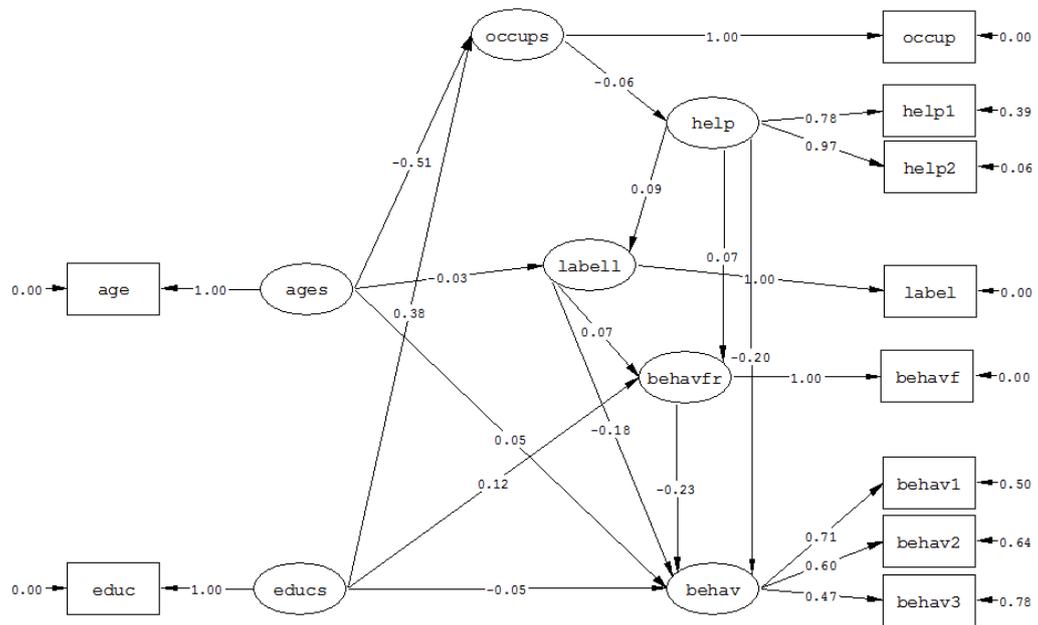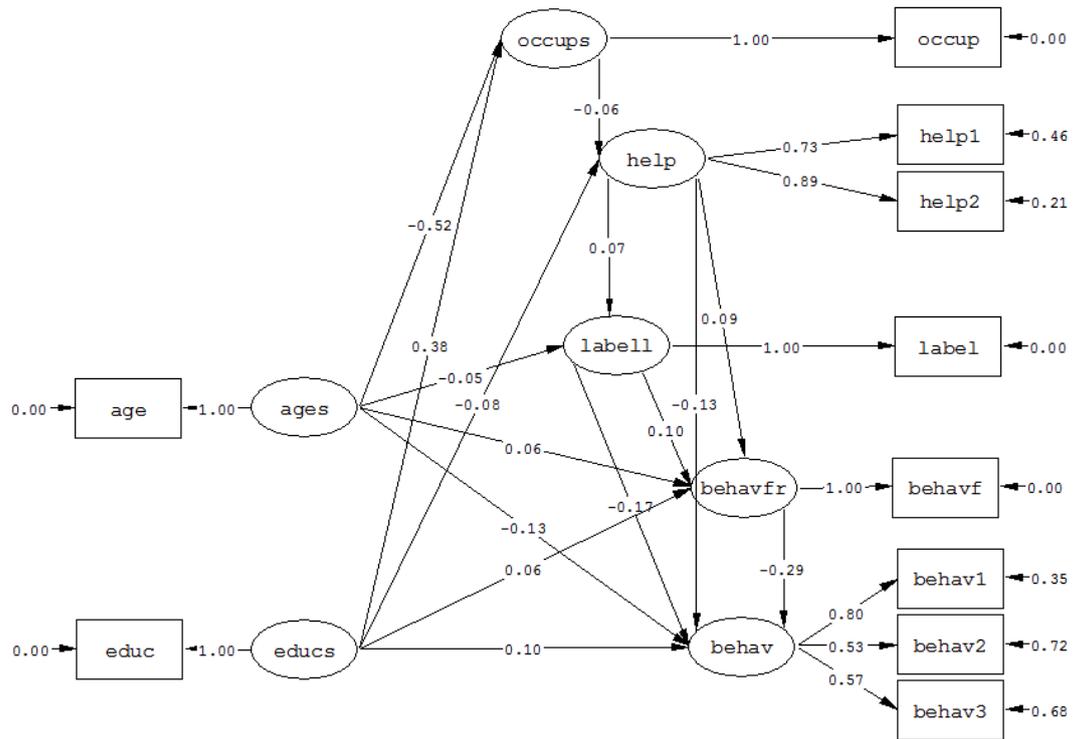
After assessing the overall models and aspects of the measurement models, the standardised structural coefficients were examined for both empirical and theoretical implications. Table 3 presents the standardised total effects between the latent variables in the model. All relationships in the three models are statistically significant.

Table 3. Standardised total (direct and indirect) effects (t-values in parentheses)*

	Total standardised effects on food waste behaviour (behav)		
	West	East	Med
Age	-0.14**	0.05*	-0.05**
Educ	0.10**	-0.07*	
Occup	0.01*	0.01*	0.09*
Help	-0.17***	-0.24***	0.06*
Label	-0.20***	-0.20***	-0.20**
Behavfr	-0.29***	-0.23***	-0.22***
R-square	0.18	0.15	0.10
Valid N	9656	9752	4535

*The latent variable scores and observational residuals depend on the unit of measurement in the observed variables. As some of these units are the result of subjective scaling of the observed variables, the observational residuals were standardised (rescaled such that they have zero means and unit standard deviations in the sample) (Jöreskog and Sörbom 2007). Total effects represent how much a one-unit change in an independent variable will change the expected value of a dependent variable.

The path diagrams for the estimated SEM models are presented in Figure 6.

0.00 → age ← 1.00 — ages — -0.29 → occups — 1.00 → occup ← 0.00

0.40
0.10 — help — 1.00 → help1 ← 0.00
0.78 → help2 ← 0.39

0.00 → educ ← 1.00 — educs

0.09 — behavfr — 0.09

0.06 — behavfr — 1.00 → behavf ← 0.00

0.08

0.00 → label ← 1.00 — labell — -0.22

-0.18 → behav

behav — 0.78 → behav1 ← 0.39
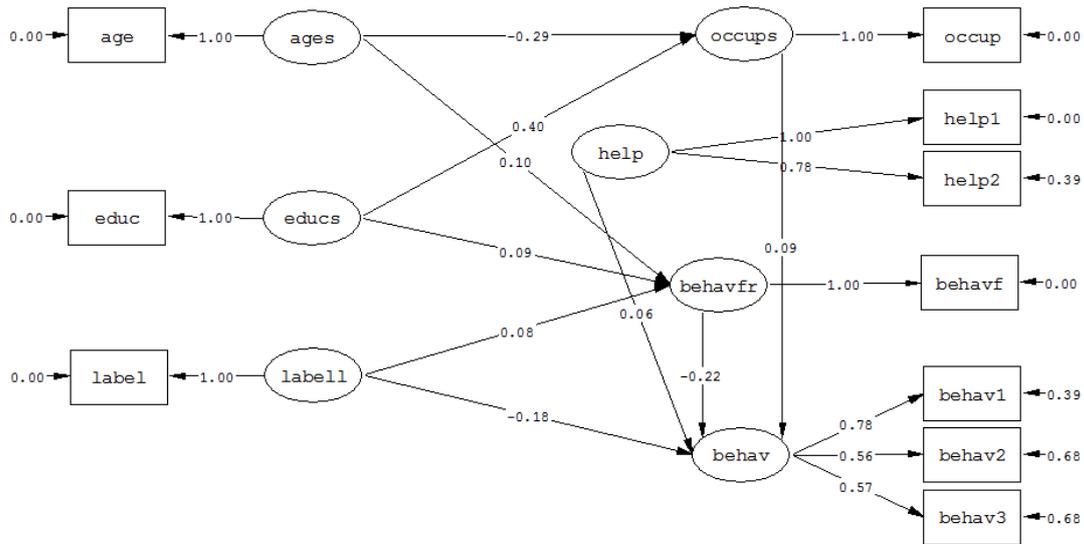0.56 → behav2 ← 0.68
0.57 → behav3 ← 0.68

Figure 6 a,b,c. SEM path diagrams (direct effects – standardised solution) for West, East and Med models

The results support the research hypotheses in the three models. Date label understanding has a negative impact on behaviour explaining a consistent fifth of the variance in the three models. Its effect on behaviour is direct and indirect through the frequency of date label checking, with which it has a significant positive relationship. The findings might indicate that consumers with a higher level of date label understanding are more likely to make regular use of date labels and less willing to consume foods without 'best before' dates or foods outside the period of time during which they must be used after opening. While the first relationship is as expected, it is less clear why consumers who understand the meaning of 'best before' labels are reluctant to disregard the absence of these labels on foods. This may be explained through the composition of the behavioural construct, which also includes an indicator with food safety implications (consumption of products which must be used within a certain number of days after opening and are past that).

Frequency of date label checking has a strong significant negative effect on behaviour explaining between a fifth and almost a third of the variance in the three models. This might indicate that consumers checking date labels regularly are less willing to consume food products which are not date-marked.

The perceived need for clearer information associated to date labelling has a significant effect on behaviour explaining up to a quarter of the variance and showing a large difference in effect magnitude and sign between the three models. Its impact on behaviour is direct and indirect through date label

understanding and frequency of date label checking. The findings suggest that people with a stronger need for clearer labelling information are in the habit of checking date labels and are more likely to understand the limitations of the current date labelling. The need for information to build stronger behavioural control leads to better interpretation of labels and lower food waste. The different relationship sign in the three models requires further investigation.

As regards socio-demographics, with the exception of education, which does not influence behaviour in the Mediterranean model, all variables have significant effects on behaviour, albeit of very different magnitude between the three models. Compared to the other influences on behaviour described above, socio-demographic variables show low effects on behaviour with the exception of age and education in the West model. The effect of age on behaviour is direct and indirect through date label understanding and frequency of date label checking. This might suggest that younger consumers have a better understanding of date marking, while older consumers are more likely to check date labels more frequently. The relationship between age and behaviour in West and Mediterranean models suggests that younger people are more likely to carry out assessments of date labels leading to behaviours associated with lower food waste. However the relationship has a different sign in the East model, which may suggest lower food waste associated with older people, which could be explained through income aspects. The sign difference between West and East models also occurs for the effect of education on behaviour and the same income-related reasoning might apply.

The effect of occupation on behaviour is direct and indirect through the perceived need for clearer date labelling information. This might suggest that consumers with better occupational status (and implicitly higher income/socio-economic group) are more likely to perceive the limitations of the current date marking and require clearer information, and are also more likely to exhibit behaviours associated with lower food waste.

A limitation of this research is the low variance explained by the models, which is due to the fact that many established influences (e.g., food safety perceptions) on the specific behaviours analysed here were missing from the survey questionnaire.

5. Conclusions

Household food consumption has been regarded as a key point in food waste generation and significant efforts by e.g., Food and Agricultural Organization of the United Nations and the European Commission have been directed to assist consumers in reducing food waste. However, there is more to be done as the majority of the current food waste mitigation initiatives together with the EU legislation tackle the food waste conundrum from a waste management perspective.

Date labelling influences the selection of food at the point of purchase and its subsequent consumption and most likely has a strong effect on consumers' decision of what to eat or throw out. Our research analysed the influence of date label understanding among other factors (socio-demographics, date label understanding, need for clearer date labelling information and frequency of date label checking) on a number of specific behaviours associated with lower food waste.

Our results suggest that the frequency of checking and understanding of date labels are the main determinants of behaviour in all regions analysed (Western, Eastern and Mediterranean Europe). However, differences between the three EU regions emerge in terms of the importance of date labelling for consumption decisions. Such differences may stem from the institutional, regulatory and policy framework, public information campaigns and food culture in these countries.

Building on the limitations of this study, future work should incorporate the role of food safety and risk perceptions, which would increase the variance explained in the analysis. Consumers have become less knowledgeable of the characteristics associated to safe and good quality food and rely increasingly on food label instructions, which may indicate insufficient control on food safety matters.

The positive relationship found between the stated level of date label understanding and the perceived need for further information on date labelling might indicate the need for changes in date labelling and for targeted communication strategies consistent with existing policy initiatives across the European Union. This is consistent with the current views of EU policy makers and national institutions, e.g., WRAP, which have proposed new guidance on the application of date labels including a flexible implementation of the date of minimum durability while maintaining strict food safety principles (WRAP 2017).

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