SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2022
ORGANIZATION AND MANAGEMENT SERIES NO. 157

SHELF-LIFE LABELLING SYSTEM IN THE OPINION OF FOOD MARKET PARTICIPANTS IN POLAND

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Purpose: The aim of the study was an assessment of the European shelf-life labelling system from the perspectives of food producers and consumers in Poland in the context of its possible impact on food waste.
Design/methodology/approach: Qualitative and quantitative research methods were used to conduct the study among key food market participants. Individual in-depth interviews (IDIs) were conducted among senior managers in 18 key food producing companies, an eye-tracking study (ET) involved 30 purposefully selected consumers, and a quantitative survey using the face-to-face interview was undertaken among food consumers in Poland (n = 1145).
Findings: The existing regulations regarding date labelling do not support the policy of establishing sustainable food chains. Even though the date label is one of the most eye-catching elements on the food packaging, a great number of Polish consumers are not able to correctly interpret the information – 39% have problems with proper understanding of 'best before' date. Less educated consumers more often admit that the information on the date label is difficult for them to comprehend. Food business operators have adopted the date labelling system as a mandatory requirement, although they consider it to be complicated.
Research limitations/implications: The research results are partially declarative. It would be interesting to examine the interpretation of the date labels in the purchasing and consumption process.
Practical implications: Consumer misunderstanding of the 'best before' date contributes to food waste. Point of view of food market participants differ what should be taken into account with regard to the final itineration of the date labelling system.
Social implications: Consumer interest in shelf-life dates should be treated as an opportunity in efficient education and building food waste prevention behaviour.
Originality/value: Triangulation of quantitative and qualitative methods was applied which allowed for a comprehensive assessment the shelf-life labelling system.

Keywords: Date labelling, 'Best before' date, Informative value, Sustainable food chains, Food waste.

Category of the paper: Research paper.

1. Introduction

The level of food waste along the supply chain in the European Union covers one-fifth of its food production, yearly reaching 88 million tons worth and a cost of 143 billion euros (Fusions, 2016). Poland ranks fifth in Europe in terms of the amount of wasted food (European Commission, 2010). In line with the '2030 Agenda for Sustainable Development', sustainable consumption and production is a challenge for the coming years. In item 12 of the Sustainable Development Goals (SDGs), halving per capita global food waste at retail and consumer levels by 2030 was postulated, as well as reducing food losses along production and supply chains (United Nations, 2015). Beside social, economics, and ethical implications of food waste, its environmental impact has been recently discussed in the context of inefficient use of natural resources. Production of food that in the end is not consumed is related to redundant land, water, labour and energy use, as well to unnecessary emission of the greenhouse gasses contributing to global warming (Chen, Chaudhary, Mathys, 2020; Padeyanda et al., 2016).

Shelf-life date is one of the mandatory elements of a food label in the EU (Regulation (EU) No. 1169/2011). Its incorporation is primarily intended to protect consumers against the consumption of unsafe outdated foods (Newsome et al., 2014). According to the European date labelling system, certain food items, from a microbiological point of view, are highly perishable and are therefore likely after a short period to constitute an immediate danger to human health. These are labelled with a 'use by' date. After this date, the food item should not be consumed. In other cases, food is labelled by the minimum durability date ('best before' date). Although food quality may not be optimal after this period, food can be safely consumed past this date.

For some time now, attention has been paid to another aspect of date labelling – how it affects consumer behavior regarding to food waste. The latest publications reveal that consumers have difficulties with distinguishing and understanding the terms on the label, by which they throw away outdated 'best before' foods, treating 'best before' dates as if they were 'use by' dates. Misunderstanding and misuse of date marking brings about premature disposal of edible food and increases the mass of wasted food (Amicarelli, Bux, 2021; Zielińska et al., 2020; Neff et al., 2019; Toma, Font, Thompson, 2020). With this in mind, the Commission announced a revision of EU rules of date labelling to take account consumer research. These activities were included in the implementation of the 'Farm to Fork' Strategy, which comprehensively addresses the challenges of sustainable food systems and recognises the inextricable links between healthy people, healthy societies and a healthy planet (European Commission, 2020b). The proposal for a revision of EU rules for food dating was included as item 27 of the draft action plan (European Commission, 2020a). The transition to sustainable food systems requires an efficient food labelling system. A clear and simple date labelling scheme is essential for conscious consumer choice and sustainable consumption in order to reduce food insecurity, ensure access to high quality and safe food and to reduce redundant

environmental impact of date labels. Understanding the perspectives of food market participants, which on the one hand – generate demand, and on the other hand – generate supply on the same market, is crucial in order to effectively manage the food labelling system. Although consumer food waste has received increasing scientific attention (Karunasena, Ananda, Pearson, 2021; Parizeau, von Massow, Martin, 2021; Aschemann-Witzel, Giménez, Ares, 2020; Ares, Giménez, Gámbaro, 2008), consumer perception of date labels, their interpretations of the meaning of 'use by' and 'best before' information, as well as point of view of the FBOs (food business operators) who act on the same market, was rather discussed separately, therefore, further work needs to be conducted in this area.

2. Literature review

In previous studies, food labelling was shown to be a tool which shapes consumer attitudes and behaviour on the food market influencing decision-making process both at the point of purchase and during food handling at home (Díaz, Fernández-Ruiz, Montaña Cámara, 2020; Latiff et al., 2016). It was noticed that food labelling might facilitate consumers to select the most healthful food options in order to maintain good overall health and reduce the risk of diet-related diseases (Croker et al., 2020; Fagerstrøm et al., 2019; Lima, Ares, Deliza, 2018; Lundeberg, Graham, Mohr, 2018). Among the elements on the label of food, shelf-life dates, composition, dietary and nutritional value get the most attention (SielickaRóżyńska, Jerzyk, Gluza, 2021; Świda, Halagarda, Popek, 2018). The importance of particular information depends on whether a purchase or consumption decision is made (Bryła, 2020; Ares, Giménez, Gámbaro, 2008). Most consumers consider compulsory information of food labelling important. In a study by Moreira et al. (2019), most respondents revealed that shelf-life information, nutritional facts and the list of ingredients influence their buying decision and are useful. Food labelling also influences industry practices, for example the value of functional food products is constantly growing due to market opportunities that nutrition and health claims make (Díaz, Fernández-Ruiz, Cámara, 2020). From reviewing 60 intervention studies by Shangguan et al. (2019), it was found that mandatory nutrient declaration induces food producers to reformulate their products, e.g., to reduce sodium and undesirable *trans* fats contents.

Subjective norms and diet-health concern were proved to be significant predictors of intention to use food labels (Vijaykumar et al., 2013). Reading the label's content takes time due to the multitude of information contained therein (Stuart, 2010). In a study by Moreira et al. (2019), half of consumers gave 'lack of time' as a reason for not reading food labels. A similar number considered the information to be too excessive. Reported problems with food labels may result in a lack of consumer motivation to use the labels. Some authors argue that

the effectiveness of the food labelling system as a tool that models consumer behaviour may be decreased if consumers experience trouble finding, interpreting, and applying information on the labels (Grunert et al., 2010). Similar negative influence may be attributed to ignoring given information or not trusting it (Rupprecht et al., 2020). Sunstein (2021) drew attention to the general phenomenon of 'information avoidance', according to which people often prefer not to know, despite the fact that information is available. Consequently, intervention actions may be in question or insufficient (Anastasiou, Miller, Dickinson, 2019).

Although households are the sector that contributes the most to food waste (over 50% of all cases) (Fusions, 2016), discarding food because of shelf-life date is also a concern of FBO's (Rosenlund et al., 2020; de Moraes et al., 2020; Jagtap, Rahimifard, 2019). Their point of view in the matter of shelf-life labelling is rarely discussed in literature. Producers also experience difficulties arising from lack of coherence and consistency of food labelling scheme (European Commission, 2010). It is their own responsibility to judge and decide which type of date – 'best before' or 'use by' date should be used on the particular food product in accordance with law requirements. Retailers and wholesalers invest heavily in compliance checks to ensure that expired food products are not offered for sale. The checking of date labels is time-consuming and complicated by the lack of uniformity of size, font, and location on the pack which extend the time it takes to complete checks. In the case of large retailers, 100 percent compliance is unlikely to ever be achieved. It was noticed that if there were fewer products with a 'use by' date then this challenge would be less (LBRO, 2011). On the other hand, the phenomenon of labelling food products with the 'use by' date instead of the date of minimum durability, not for safety reasons, but in order to avoid a situation that a product of reduced quality after the date of minimum durability will go to the consumer, has been already observed (LBRO, 2011). FBO's are afraid of increased probability of complaints, brand damage, loss of consumer trust, and even loss of the market (Harcar, Karakaya, 2005). Another issue is that interpretation if food can be sold after minimum durability date varies across the European Union – some local regulations are more restrictive and treat selling the outdated 'best before' food as an offence (Varallo, 2013; Ustawa, 2019). There is, however, no consensus amongst key players on the impact of possible removing 'best before' date on food waste prevention (Raikos, Gassin, 2018). Some manufacturers believe that the period of time during which food operators are responsible for food quality would be undefined if there were no minimum durability dates (Domka-Rybka, 2014).

An efficient food labelling system is necessary to protect all the participants of the food market. A clear and simple shelf-life labelling scheme is needed for conscious consumers' choices and sustainable consumption. Developing an efficient labelling system or modifying of an existing one requires the consideration and understanding of both consumers' and producers' point of view in the discussed area.

The main goal of the present study was to comprehensive assess the European date labelling system from the point of view of market participants in Poland (food producers and consumers) in the context of food waste. The specific research goals correlated with the main goal and were as follows:

- evaluating the functioning system of the shelf-life labelling system, together with an indication of the key problems related to this system from the point of view of food producers in Poland,
- identifying and assessing consumer involvement in the processing of information on the shelf-life of products (in relation to selected food products),
- ascertaining the Polish consumers' perception of the shelf-life labelling system in terms of difficulties in interpretation and understanding of the date types.

3. Material and methods

The achievement of the set goals required an advanced research process including both qualitative and quantitative research. Triangulation of quantitative and qualitative methods allowed for a comprehensive assessment of how the date labelling system is perceived by market participants in Poland. The overview of the research approach is presented in Figure 1.

The research process consisted of three stages:

- stage 1: qualitative research carried out using the individual in-depth interview (IDI) method among senior managers in 18 key producers of food from the following categories: confectionery, tea and coffee, fruit and vegetable products, milk and dairy products. Producers were selected on purpose – they were market leaders in Poland in the analyzed product categories (market shares were the criterion for selecting entities for research). The study was conducted in the period from December 2018 to April 2019, in Poland. The research tool was a semi-structured interview questionnaire;
- stage 2: a qualitative eye-tracking study (ET) conducted among 30 purposefully selected consumers. The research population consisted of consumers declaring the systematic purchase of milk. The study was conducted in July 2019, by employing SMI Eye Tracking Glasses 2 Wireless systems with built-in HD cameras, which automatically corrected errors and recorded eye movements at a speed of 60 Hz. The used ET recorded the respondents' eye directions based on a 3-point calibration. The ET study was prepared using OpenSesame. Additionally, ET was supported by a qualitative research carried out using the individual face-to-face interview method among the participants of the ET survey. The direct interview research tool was the short interview questionnaire;

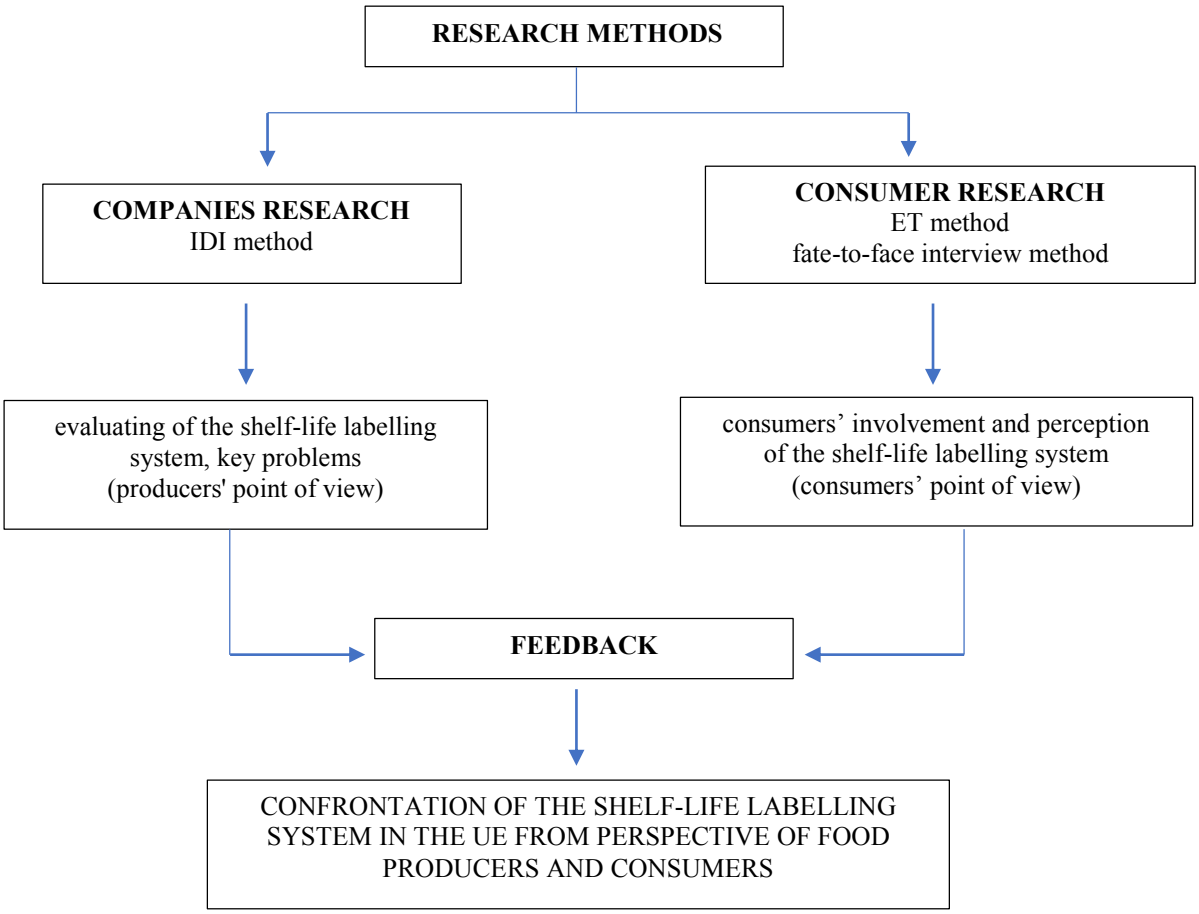

Figure 1. The overview of the research approach. Source: own study.

- stage 3: a quantitative survey conducted by means of applying the face-to-face interview method among consumers in Poland. The research population consisted of consumers declaring the systematic purchase of food products. The selection of the research sample (n = 1145) was carried out by the quota method (selection criteria: gender, age and place of residence), which met the demand for maintaining the relative representativeness of the research population. The study was conducted in the period from April to June 2019. The research tool was an interview-structured questionnaire prepared and verified in piloting (based on the pilot study (n = 100), the interview questionnaire was modified). The interviews of consumers included questions aimed at recognizing the opinions held by individual consumers on communicativeness of the date labelling system, as well as at exploring whether consumers correctly interpret the date labelling. In the process of empirical data analysis, an IBM SPSS Statistics tool was applied.

The conducted research made it possible to confront the consumers' declarations regarding the perception and evaluation of the date labelling system with the actual involvement of consumers in the analysis and processing of information on the 'use by' and 'best before' dates.

4. Results and discussion

4.1. The food date labelling system in the opinion of the surveyed companies

The main goal of the individual in-depth interview (IDI) in the food producers sector in Poland was to assess the merits and faults of the food labelling system currently functioning in Poland and the European Union (in terms of legibility, communication and ease of interpretation). The questions stated in the interviews concerned the following issues:

- assessing communicativeness and ease of interpretation of the date labelling system from the producers' point of view,
- deriving producers' opinions on the possible future simplification of the food date labelling system through:
  1. simplifying the way of minimum durability date indication,
  2. abolishing the concept of 'best before' date,
- identifying the most significant problems related to the current food labelling systems that, in the opinion of producers, may affect consumers' misinterpretation of information.

The IDI survey results are presented in Table 1.

Table 1.
Assessment of the date labelling system by the surveyed companies

Research problems	Food market sectors			
	Confectionery	Milk and dairy products	Coffee and tea	Fruit and vegetable products
Legibility and clarity of communication of date labelling system from enterprises' point of view	• the system is quite complicated • the system is readable by FBO's • communicative guidelines, but not very simple			
The probability of problems in interpretation by consumers according to enterprises' point of view	• probably the system is not readable and complicated for consumers • consumers may tend not to differentiate between 'best before' and 'use by' dates • education of consumers with a wide social range is necessary in order to correctly interpret the labelling			
The preferred way of minimum durability date indication				
− 'best before...' [DD-MM YYYY]		✓		
− simplification the way of date indication: 'best before end...' [MM-YYYY] (or [YYYY])	✓		✓	✓
Abolishing the concept of 'best before' date	unnecessary	unnecessary or only 'use by' date	unneces-sary	unnecessary

Source: own study.

According to the results of our survey, companies assess the food date labelling system in the European Union countries as quite complex, but legible from the point of view of entities. This is conditioned by the fact that it is necessary to implement these solutions and adapt to

legal guidelines, which is a sine qua non-condition for introducing food products to the market. On the other hand, the surveyed companies suspect that the date labelling system can cause many interpretation difficulties for the consumers. They agreed that the current date labelling system is probably not understandable and communicative for consumers who may have problems with delineating and correctly interpreting the phrases: 'use by' and 'best before'. The above can generate wasting behaviour due to misunderstanding of the information on the product packaging. It should be noted that not only the two kinds of the dates ('use by' and 'best before'), but also a variety of other date formats have been discussed by several authors in the field as key factors causing confusions (Chu at al., 2020).

The surveyed companies unequivocally emphasize that the correct interpretation of information on the shelf-life of food by consumers depends on their awareness and knowledge in this regard. According to the respondents' opinion, the level of consumer awareness is relatively low, therefore, extensive communication and educational activities in this area should be undertaken. Such actions should be implemented by government regulators, non-governmental organizations and by the economic entities (production and trade) themselves. Upon analysing in full the results of the study in the context of possible future simplification of the labelling system, it can be concluded that the vast majority of the surveyed entities (companies from the sector of confectionery, tea and coffee, fruit and vegetable products) do not see the need to unify the labelling procedure. The surveyed entities have implemented the European Union's recommendations in this regard and do not see the need for changes. Moreover, their production portfolio includes mainly shelf stable products, so these companies use only minimum durability dates of fairly long term and have no problems with deciding about the type of the shelf-life date.

Simplification of the date labelling system to a single set of terminology has been earlier postulated as a result of interviews conducted with ten industry practitioners from Australia (Chu et al., 2020). In the present study, agreement to this notion is presented, albeit only by companies involved in dairy item production. They take the position that one should consider simplification of the system and limit it to the 'use by' date. The view of entities in the milk products sector is due to the fact that they offer both fresh products (e.g. fresh milk – pasteurized and microfiltered milk) and products with a long shelf-life (e.g. UHT milk – ultra high temperature sterilized milk), and the above is related to different ways of labelling products.

Referring to the possible simplification of the way of date indication, entities operating within the milk products market indicated that they prefer to specify the exact date, and entities from other sectors indicated that they prefer giving only the month and year or only a year. Changes of food labelling system consisting of introducing one of the two date types: the date of production or the 'use by' date were proposed by one company operating in the confectionery sector. This, in their opinion, would make the date label more readable and understandable for consumers. Moreover, it would reduce the interpretation problems, and thus limit the undesirable, irrational behaviour of consumers related to the consumption of outdated 'use-by'-

labelled or disposal of products that are safe and edible. The advantage of this proposal would be that it does not deprive consumers of information – an issue that Polish producers had earlier feared (Domka-Rybka, 2014).

4.2. Consumers' interest in shelf-life dates on food packaging

One of the study's goals was to identify the involvement of consumers in Poland in the processing of information on shelf-life of food ('use by' date and 'best before' date) placed on food unit packaging. The test was carried out using the ET technique, which has been employed earlier to gain knowledge on consumer involvement in processing of information regarding food composition and dietary properties (Sielicka-Różyńska, Jerzyk, Gluza, 2021; Bialkova, Grunert, van Trijp, 2020; Zuschke et al., 2020). The subject of the study was the packaging of fresh (pasteurized and microfiltered milk labelled with 'use by' date) and packaging of UHT (ultra high temperature sterilised milk labelled with 'best before' date). The participants' answers to the question: "Do you know the difference between the 'best before' date and the 'use by' date?" showed that not one participant could tell the differences between 'use by' and 'best before' dates. The participants of ET study claimed that these terms are synonyms.

The results of the ET study were presented in the form of heat maps and area of interest analysis (AOI). AOI was distinguished by grouping information elements on the presented milk packages. One of the identified areas of packaging interest was information on the shelf-life of fresh milk (which is communicated by the 'use by' date) and UHT milk (which is communicated by the 'best before' date).

The following ET parameters were used in the analysis of consumer interest in information on the shelf-life of milk placed on the packaging:

- entry time – the time after which the respondent looked at a particular AOI,
- sequence – the order of looking at the selected areas of AOI,
- dwell time – the time of looking at the separated area of the AOI.

Heat maps for fresh milk packaging are presented in Figure 2.

Figure 2. Heat maps of fresh milk packaging. Source: own study.

The basic ET parameters for fresh milk are presented in Table 2.

Table 2.
Basic parameters for ET – fresh milk packaging

Area of interest analysis (AOI)	Entry time in ms (average)	Sequence	Dwell time in ms (average)
A nutrition declaration, 'pasteurised, microfiltered, fresh milk', conditions of storage	2790.3	1	6828.6
'Fresh milk' and fat content (front)	3212.1	2	720.3
Product name (front)	3883.3	3	922.2
Logo (front)	4945.4	4	1006.8
White space	7209.7	5	837.0
'Use by' date	7279.3	6	1571.1
Net quantity (volume) (front)	9915.1	7	130.6
Additional information	10783.1	8	4058.8
Bar code	11074.7	9	111.2
Logo (back)	13147.6	10	442.5
Product name (back)	16719.9	11	262.2
'Fresh milk' and fat content (back)	20193.2	12	276.1
Net quantity (volume) (back)	21401.8	13	95.1

Source: own study.

As shown by the results in Figure 2 and Table 2, in fresh milk packaging, the elements that attract the most attention are nutrition declaration (on the front of the packaging) and information about the product (on the back of the packaging). The respondents devoted relatively much attention to exploring the product's 'use by' date – indeed, it is the third most eye-catching element of the packaging. The subjects looked at it for an average of 1571 ms. After the packaging elements are normalized (that is, taking into account their size), the 'use-by' date becomes the area that attracts the most attention. Heat maps for UHT milk packaging are shown in Figure 3.

Figure 3. Heat maps of UHT milk packaging. Source: own study.

The basic ET parameters for fresh milk are presented in Table 3.

Table 3.
Basic parameters for ET – UHT milk packaging

Area of interest analysis (AOI)	Entry time in ms (average)	Sequence	Dwell time in ms (average)
Product name (front)	2873.6	1	1507.4
A nutrition declaration, 'UHT milk', conditions of storage	4662.7	2	7279.7
Fat content (front)	5532.1	3	416.1
White space	5580.7	4	885.4
Logo (front)	5789.9	5	259.8
Product name (back)	6970.0	6	1455.9
Additional information	7556.0	7	2418.9
'Best before' date	8826.2	8	1918.7
'Source of calcium' nutrition claim	9264.8	9	552.3
Logo (back)	9743.8	10	186.0
Fat content (back)	9880.0	11	232.4
Bar code	10345.3	12	106.4
Net quantity (volume)	13057.0	13	159.6

Source: own study.

In the case of UHT milk, the packaging elements that attract the most attention are the nutrition declaration and detailed information about the product. The surveyed individuals devoted relatively much attention to the exploration of the date of minimum durability – it was the third most eye-catching element of the packaging. The surveyed looked at it for an average of 1919 ms. Detailed product information remains the area that attracts the most attention after standardization of packaging components (taking into account their size).

Summarizing the results of ET in terms of consumer involvement in the processing of information on shelf-life placed on milk packaging, it can be stated that regardless of the product category (fresh milk/UHT milk), the information about the 'use-by' or 'best before' date attracted relatively much respondent attention. The results obtained in this study are in agreement with a study of Świda, Halagarda, Popek (2018), where the most sought information was the 'use by' or 'best before' date, followed by the product composition and the name of the producer. Świda, Halagarda, Popek (2018) demonstrated that ease of finding the shelf-life date depended on the age of consumers and the place where the information was printed on the packaging.

4.3. Consumer perception and interpretation of the food date labelling system

In this study, we also sought to identify the opinions of individual consumers on the communicativeness of the date labelling system and to assess whether consumers correctly interpret the assigned date labelling. The following question was asked: "How do you rate the date labelling system in terms of ease of interpretation?". As shown in Table 4, most consumers in Poland (66.4%) declare that the date labelling system is not difficult to interpret (it is very easy/easy/rather easy). In turn, 19.0% of the respondents cannot assess it, and 14.6% claim that

the system is difficult to interpret (very difficult/difficult/rather difficult). Therefore, it can be assumed that 2/3 of consumers in Poland evaluate the date labelling system positively in terms of ease of interpretation, while the remaining 1/3 of consumers have difficulties with the correct interpretation of the information proffered by the 'use by' and 'best before' dates.

It should be noted that incorrect interpretation may lead to irrational behaviour of consumers with regard to food handling after expiration, i.e. tasting, consuming or processing outdated food labelled with the 'use by' date, which is associated with a high health risk. On the other hand, consumers may irrationally throw away expired food labelled with a minimum durability date, which would contribute to increasing food waste. In this context, an interesting research issue was also to discern consumer opinions about interpretation difficulties with regard to the date labelling system, taking into account the variables of consumer gender and education.

Table 4.
Assessment of the food labeling system in terms of ease of interpretation (%)

Variants of answers	Total		Women		Men	
Very difficult to interpret	0.9		1.1		0.6	
Difficult to interpret	4.8	14.6	4.5	14.0	5.3	13.3
Rather difficult to interpret	8.0		8.4		7.4	
I have no opinion	19.0		16.9		21.4	
Rather easy to interpret	35.9		36.4		35.6	
Easy to interpret	22.9	66.4	24.8	69.1	20.6	65.3
Very easy to interpret	8.5		7.9		9.1	

Source: own study.

The analysis of the assessment of the difficulty in interpreting information on the 'use by' and 'best before' dates in relation to the gender of consumers using the independent samples t-test showed no statistically significant differences in the case of gender (two-sided significance 0.577). Therefore, it can be assumed that gender is not a variable differentiating consumer opinions in the analyzed scope, which is reflected in Table 5.

Table 5.
Independent samples t-test

-	Levene's test of equality of variancess		Test t for Equality of Means				
-	S	Sig.	t	df	Sig.	Means Difference	Std Error Difference
Equal variances assumed	0.080	0.777	-0.558	1133.0	**0.577**	-0.043	0.076
Equal variances no assumed			-0.559	1095.710	**0.577**	-0.043	0.000

Source: own study.

In the case of consumer education, the starting point for the analysis was the assessment of the significance index between the variables ('assessment of the current food labelling system for ease of interpretation' and 'consumer education') in terms of the education of the respondents based on the one-way analysis of variance and the Spearman correlation index. The results of the one-way ANOVA presented in Table 6 show a significance level of 0.000,

which means that the differences in answers due to the level of consumer education are statistically significant.

Table 6.
The results of one-way Anova

Source of variation	Sum of Squares	df	Mean Square	S	Sig.
Between groups	49.131	3	16.377	10.327	0.000
Within groups	1761.789	1111	1.586		
Total	1810.920	1114			

Source: own study.

The assessment of the food date labelling system in terms of ease of interpretation depending on the education of consumers is presented in Figure 4.

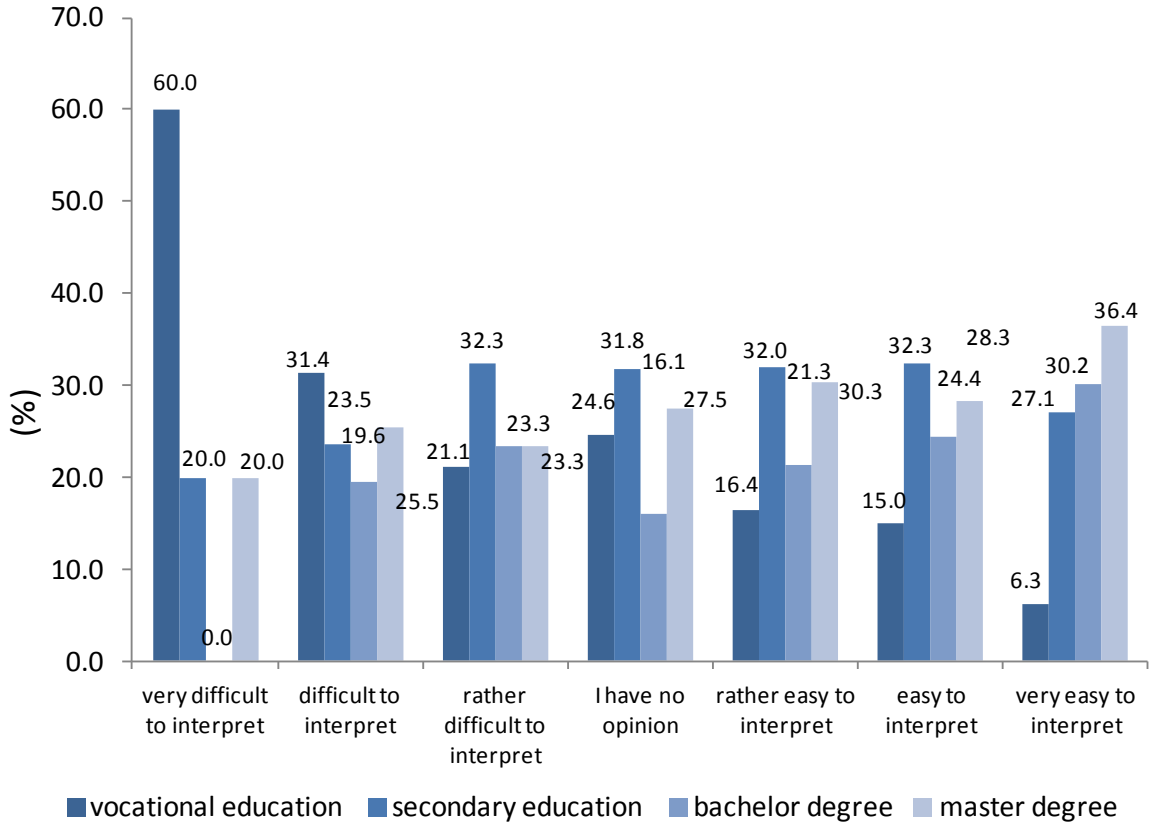

Figure 4. The assessment of the food date labelling system in terms of ease of interpretation depending on the education of consumers. Source: own study.

Our survey results indicate that the degree of difficulty in interpreting information on the ‘use by’ or ‘best before’ dates of a food depends on the education level. In general, it can be stated that, in the opinion of more educated consumers, the food date labelling system is easy to interpret. In contrast, in the segment of consumers who declare that the information on the ‘use by’ or ‘best before’ dates is difficult to interpret, the highest percentage are consumers with the lowest level of education. For example: in the segment of consumers who rate the food date labelling system as ‘very difficult to interpret’ as many as 60.0% are people with vocational education. In the segments assessing this system as ‘difficult’ and ‘rather difficult’, 31.4% and

21.1% of consumers have vocational education. On the other hand, in the group of consumers who evaluate the date labelling system as easy to understand, a higher percentage of consumers have a bachelor's / master's degree. For example: the answer 'very easy' is declared by only 6.3% of consumers with a vocational training, but as many as 36.5% with a master degree. Therefore, it can be concluded that most consumers with a higher level of education declare that the current date labelling system is 'very easy / easy / rather easy' to interpret; in turn, in the opinion of consumers with the lowest education level, this system is difficult to interpret.

In the literature, no consistency exists over the role of gender and level of education on household food waste (Falasconi et al., 2019; Fanelli, 2019; Schanes, Dobernig, Gözet, 2018; Filipová et al., 2017). There are data, however, showing positive correlation between level of education with food provisioning in households (Fami et al., 2021; Karunasena, Ananda, Pearson, 2021).

Ease of understanding of food labelling system is important for proper food handling, therefore, our study points the role of out-of-school consumer education, especially for less educated individuals. Uncertainty about how to proceed with food after passing shelf-life date and doubts regarding its safety is the driver of food waste (Ankiel, Samotyja, 2020). Consumers who find the date labelling system difficult to understand may represent less motivated preventive behaviour (van Geffen et al., 2020).

Another research objective was to assess whether consumers correctly interpret the information on the 'use by' and 'best before' dates on product packaging. Consumers were shown two dates (one minimum durability date and one 'use by' date) and asked a question if food can be consumed after passing of the dates. The results (Table 7) show that in the case of the date of minimum durability, only 61.0% of consumers were able to correctly interpret it, more than 1/3 of the respondents interpreted it incorrectly (indicating, for example, that after this date food should not be consumed, but disposed of), and 5.0% did not know how to interpret this information. More optimistic results were obtained in the case of the 'use by' date – a much larger percentage of consumers – 79.0% were able to correctly interpret this information, while 21.0% of all respondents misinterpreted it or admitted that they could not do so.

Table 7.
Interpretation of the 'use by' and 'best before' dates by consumers (%)

Variants of answers	Correct interpretation	Incorrect interpretation	'I don't know'
Best before 05.06.2020	61.0	33.9	5.1
Use by 05.06.2020	79.0	16.1	4.9

Source: own study.

The percentage of consumers who do not understand shelf-life dates, as well as consumers who rate the labelling system as difficult is not optimistic. Our results are in agreement with studies conducted in other European countries in which consumers' confusion about the date label was indicated (Toma, Font, Thompson, 2020; Van Boxstael et al., 2014). In the study of Wikström et al. (2014), consumers express the need for clear shelf-life information. The above

underlines the notions that the date labelling system in force in the European Union countries is ineffective from the consumers' point of view, and that consumers in the EU (including Poland) are not properly educated. The potential effects of poor communicativeness and readability of the shelf-life labelling system are presented in Figure 5.

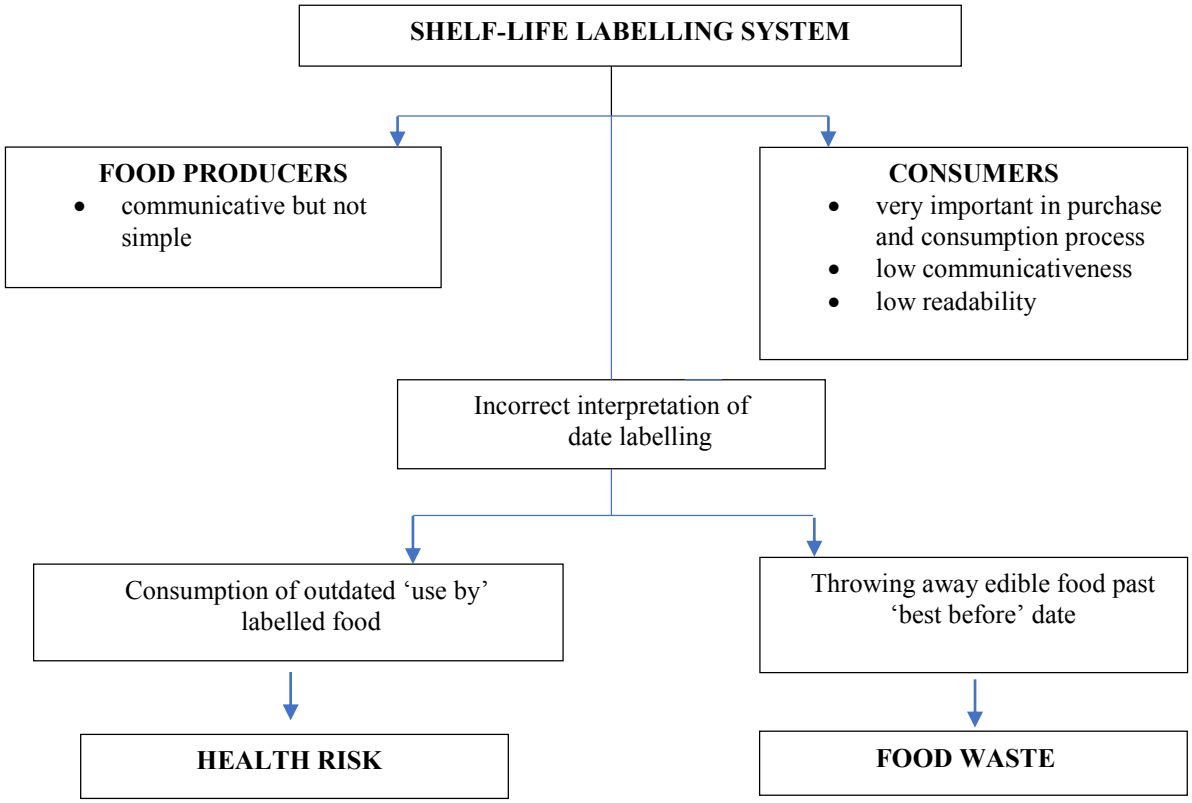

Figure 5. Potential effects of poor communicativeness and readability of the date labeling system Source: own study.

Misinterpretation of the 'best before' date labels contributes to global food waste problem because edible and safe food is being thrown away. Schanes, Dobernig, Gözet (2018) state that a big potential for reducing food waste lies in optimising labels, e.g. redesigning them or adding additional guidance. During the Covid-19 virus outbreak lockdown, the problem of food wastage due to expiration dates in households was maintained (Jribi et al., 2020).

5. Conclusions and recommendations

The advanced research process, involving the food market in Poland, provides interesting conclusions and allowed for numerous recommendations. Firstly, the date labelling system functioning in the EU countries was assessed by the survey participants as not very communicative and legible. Still, companies have adopted this system (which was a mandatory requirement on the food market), and it is understandable to them. According to the majority

of enterprises operating in the field of food supply, possible unification of the system to only one type of the date is not necessary; the only exception are companies working within the milk sector, which would benefit from this solution. In the opinion of food producers, however, consumers may have a problem with distinguishing and thus correctly interpreting 'use by' and 'best before' dates. This assumption has been confirmed in research conducted among food consumers in Poland.

Information on the 'use by' or 'best before' date is one of the most important pieces of information engaging consumers' interest. Consumer involvement in processing information on the shelf-life dates should, therefore, be associated with the correct interpretation of this information, otherwise the information will not play its intended role.

What actions should be taken to increase consumer awareness of the date labelling system and to avoid mishandling out-dated food? The surveyed companies indicate that consumer education is of key importance in this respect. Consumers' interest in shelf-life dates, as indicated in the ET study, is optimistic and should be treated, along with consumer education, as an opportunity to advance communication. Educational activities should be carried out not only for mature consumers, but also for young market participants (primary school students) using various channels and forms of communication, such as traditional media, social media, lectures and projects. Communication at points of sale in the form of banners and posters explaining how to interpret shelf-life information is also important.

That less educated consumers admit that the information on the date labels is difficult for them indicates that there is a need to initiate campaigns especially dedicated for this segment of the food market. Companies should consider the possibility of placing additional educational information on the packaging, both in the form of linguistic and graphic signs (pictograms), which have a high communication value. Intelligent food packaging is a relatively new and quite popular solution used in some markets. Such packaging allows traders and consumers to continuously assess the quality condition of the packaged food as it very communicatively and simply indicates when the food should be thrown away because it is not suitable for consumption. Unfortunately, such solutions have not been implemented on the Polish food market yet, mainly due to the high commercialization costs. Therefore, the most important actions that should be taken are educational activities that will increase consumer awareness of the date labelling system and of food waste.

Beyond the aforementioned, special care should be paid during revisiting the existing law regulation and during prospective changing of the rules or improvement of expression and presentation of food dating. Our study showed how much market position and point of view of producers and consumers differs and how great the challenge is in designing a system that would be suitable for all FBOs.

6. Limitations and future research directions

The study and its conclusions have limitations related to the adopted research procedure and the research method and technique. It is worth emphasizing that the respondents' answers, and thus the research results, are partially declarative. Consumers' declarations may differ from their actual behaviour in the process of purchasing and consuming food products. However, the used ET test allows recognition of the consumers' actual behaviour, in this case concerning their interest in the information on the 'use by' and 'best before' dates placed on the packaging.

One of the significant research limitations in the ET study came about with regard to the information on the shelf-life of fresh and UHT milk. This is due to the fact that in Poland, producers market fresh and UHT milk in different packaging, both in terms of graphics, colours and often – construction forms). Nevertheless, it would be interesting to recognize the role and importance of information on food durability in the food purchasing process, and to examine the interpretation of this information in the purchasing and consumption process (e.g. in the course of ethnographic research).

Acknowledgements

This study was supported by the National Science Centre (Narodowe Centrum Nauki), Poland [grant number 2017/27/B/HS4/00805].

References

1. Amicarelli, V., Bux, C. (2021). Food waste in Italian households during the Covid-19 pandemic: a self-reporting approach. *Food Security*, *13*, 25-37, doi.org/10.1007/s12571-020-01121-z.
2. Anastasiou, K., Miller, M., Dickinson, K. (2019). The relationship between food label use and dietary intake in adults: A systematic review. *Appetite, 1*(*138*), 280-291, doi: 10.1016/j.appet.2019.03.025.
3. Ankiel, M., Samotyja, U. (2020). The role of labels and perceived health risk in avoidable food wasting. *Sustainability*, *12*(*20*), 8725, doi:10.3390/su12208725.
4. Ares, G., Giménez, A. Gámbaro, A. (2008). Sensory shelf-life estimation of minimally processed lettuce considering two stages of consumers' decision-making process. *Appetite*, *50(2-3),* 529-535, doi: 10.1016/j.appet.2007.11.002.

5. Aschemann-Witzel, J., Giménez, A., Ares, G. (2020). Suboptimal food, careless store? Consumer's associations with stores selling foods with imperfections to counter food waste in the context of an emerging retail market. *Journal of Cleaner Production*, *262*, 121252, doi: 10.1016/j.jclepro.2020.121252.
6. Bialkova, S., Grunert, K.G., van Trijp, H. (2020). From desktop to supermarket shelf: Eye-tracking exploration on consumer attention and choice. *Food Quality and Preference*, *81*, 103839, doi: 10.1016/j.foodqual.2019.103839.
7. Bryła, P. (2020). Who Reads Food Labels? Selected Predictors of Consumer Interest in Front-of-Package and Back-of-Package Labels during and after the Purchase. *Nutrients*, *12*, 2605. doi: 10.3390/nu12092605.
8. Chen, C., Chaudhary A., Mathys, A. (2020). Nutritional and environmental losses embedded in global food waste. *Resources, Conservation and Recycling*, *160*, 104912, doi: 10.1016/j.resconrec.2020.104912.
9. Chu, W., Williams, H., Verghese, K., Wever, R., Glad, W. (2020). Tensions and opportunities: an activity theory perspective on date and storage label design through a literature review and co-creation sessions. *Sustainability*, *12*(3), 1162, doi: 10.3390/su12031162.
10. Croker, H., Packer, J., Russell, S.J., Stansfield, C., Viner, R.M. (2020). Front of pack nutritional labelling schemes: a systematic review and meta-analysis of recent evidence relating to objectively measured consumption and purchasing. *Journal of Human Nutrition and Dietetics*, *33*(4), 518-537, doi: 10.1111/jhn.12758.
11. de Moraes, C., de Oliveira Costa, F.H., Pereira, C.R., da Silva, A.L., Delai, I. (2020). Retail food waste: mapping causes and reduction practices. *Journal of Cleaner Production*, *256*, 120124, doi: 10.1016/j.jclepro.2020.120124.
12. Díaz, D.L., Fernández-Ruiz, V. Cámara, M. (2020). An international regulatory review of food health-related claims in functional food products labelling, *Journal of Functional Foods*, *68*, 103896, doi: 10.1016/j.jff.2020.103896.
13. Domka-Rybka, A. (2014). *Z opakowań zniknie data minimalnej trwałości produktów. Klient oceni sam czy np. nie zatruje się serem*. Retrieved from http://www.strefabiznesu.pomorska.pl/artykul/z-opakowan-zniknie-data-minimalnej-trwalosci-produktow-klient-oceni-sam-czy-np-nie-zatruje-sie-serem, 09.10.2020.
14. European Commission (2010). Preparatory Study on Food Waste Across EU 27, Paris.
15. European Commission (2020a). Annex to the communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions a Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system.
16. European Commission (2020b). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee

of the Regions a Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system.

17. Fagerstrøm, A., Richartz, P., Pawar, S., Larsen, N.M., Sigurdsson, V. Eriksson, N. (2019). The relative importance of healthy food labels when shopping for groceries online. *Procedia Computer Science*, *164*, 538-545, doi: 10.1016/j.procs.2019.12.217.
18. Falasconi, L., Cicatiello, C., Franco, S., Segrè, A., Setti, M., Vittuari, M. (2019). Such a shame! A study on self-perception of household food waste, *Sustainability*, *11*, 270, doi.org/10.3390/su11010270.
19. Fami, H.S., Aramyan, L.H., Sijtsema, S.J., Alambaigi, A. (2021). The relationship between household food waste and food security in Tehran city: The role of urban women in household management, *Industrial Marketing Management*, 97, 71-83, doi.org/10.1016/j.indmarman.2021.06.016.
20. Fanelli, R.M. (2019). Using causal maps to analyse the major root causes of household food waste: Results of a survey among people from central and southern Italy. *Sustainability*, *11*, 1183, doi.org/10.3390/su11041183.
21. Filipová, A., Mokrejšová, V., Šulc, Z., Zeman, J. (2017). Characteristics of food-wasting consumers in the Czech Republic. *International Journal of Consumer Studies, 41*, 714-722, doi.org/10.1111/ijcs.12384.
22. Fusions (2016). *Estimates of European food waste levels*. IVL Swemeal Environmental Research Institute. Retrieved from http://www.eu-fusions.org, 09.10.2020.
23. Grunert, K.G., Fernández-Celemín, L., Wills, J.M., Bonsmann S., Nureeva, L. (2010). Use and understanding of nutrition information on food labels in six European countries. *Zeitschrift fur Gesundheitswissenschaften, 18(3),* 261-277, doi: 10.1007/s10389-009-0307-0.
24. Harcar, T., Karakaya, F. (2005). A Cross-Cultural Exploration of Attitudes Toward Product Expiration Dates. *Psychology & Marketing*, *22*, 353-371, doi: 10.1002/mar.20063.
25. Jagtap, S., Rahimifard, S. (2019). The digitisation of food manufacturing to reduce waste – case study of a ready meal factory. *Waste Management*, *87*, 387-397, doi: 10.1016/j.wasman.2019.02.017.
26. Jribi, S., Ben Ismail, H., Doggui, D. Debbabi, H. (2020). COVID-19 virus outbreak lockdown: What impacts on household food wastage? *Environment, Development and Sustainabiliy, 22*, 3939-3955, doi.org/10.1007/s10668-020-00740-y.
27. Karunasena, G.G., Ananda, J., Pearson, D. (2021). Generational differences in food management skills and their impact on food waste in households. *Resources, Conservation and Recycling, 175*, 105890, doi.org/10.1016/j.resconrec.2021.105890.
28. Latiff, Z.A.A., Ruslee, N.A., Ayob, M.A. (2016). Factors influencing consumer purchasing intention based on food labels, *International Business and Management*, *13*(1), 41-45. doi: 10.3968/8679.

29. LBRO (2011). *Better Regulation of 'Use By' Date Labelled Foods: A Business View'*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/262575/11-1474-use-by-dates-report.pdf, 12.11.2020.
30. Lima, M., Ares, G., Deliza, R. (2018). How do front of pack nutrition labels affect healthfulness perception of foods targeted at children? Insights from Brazilian children and parents. *Food Quality and Preference*, *64*, 111-119, doi: 10.1016/j.foodqual.2017.10.003.
31. Lundeberg, P.J., Graham, D.J., Mohr, G.S. (2018). Comparison of two front-of-package nutrition labelling schemes, and their explanation, on consumers' perception of product healthfulness and food choice. *Appetite*, *1*(*125*), 548-556, doi: 10.1016/j.appet.2018.02.027.
32. Moreira, M.J., García-Díez, J., de Almeida, J.M.M.M., Saraiva, C. (2019). Evaluation of food labelling usefulness for consumers. *International Journal of Consumer Studies*, *43*(3), 27-334, doi: 10.1111/ijcs.12511.
33. Neff, R., Spiker, M., Rice, C., Schklair, A., Greenberg, S., Leib, E.B. (2019). Misunderstood food date labels and reported food discards: A survey of U.S. consumer attitudes and behaviors. *Waste Management*, *86*, 123-132, doi: 10.1016/j.wasman.2019.01.023.
34. Newsome, R., Balestrini, Ch.G., Baum, M.D, Corby, J., Fisher, W., Goodburn, K., Labuza, P.T., Prince, G., Thesmar, H.S., Yiannas, F. (2014). Applications and perceptions of date labelling of food. *Comprehensive Reviews in Food Science and Food Safety*, *13*, 745-769, doi: 10.1111/1541-4337.12086.
35. Padeyanda, Y., Jang, Y.-Ch., Ko, Y., Yi, S. (2016). Evaluation of environmental impacts of food waste management by material flow analysis (MFA) and life cycle assessment (LCA), *Journal of Material Cycles and Waste Management*, *18*, 493-508, doi: 10.1007/s10163-016-0510-3.
36. Parizeau, K., von Massow, M., Martin, R.C. (2021). Directly observing household food waste generation using composition audits in a Canadian municipality. *Waste Management*, *135*, 229-233, doi.org/10.1016/j.wasman.2021.08.039.
37. Raikos, A., Gassin, A.-L. (2018). *EU action to promote better understanding and use of date marking*. Retrieved from https://webcache.googleusercontent.com/search?q=cache:aQRT-N9mbN8J:https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-platform_20180420_sub-dm_pres-01.pdf+&cd=1&hl=pl&ct=clnk&gl=pl&client=firefox-b-d, 12.11.2020.
38. Regulation (EU) No. 1169/2011 of The European Parliament and of The Council of 25 October 2011 on the provision of food information to consumers..., OJ L 304, 22.11.2011, 18-63.
39. Rosenlund, J., Nyblom, Å., Matschke Ekholm, H., Sörme, L. (2020). The emergence of food waste as an issue in Swedish retail. *British Food Journal*, *122*(*11*), 3283-3296, doi: 10.1108/BFJ-03-2020-0181.

40. Rupprecht, Ch.D.D., Fujiyoshi, L., McGreevy, S.R., Tayasu, I. (2020). Trust me? Consumer trust in expert information on food product labels. *Food and Chemical Toxicology*, *137*, 111170, doi: 10.1016/j.fct.2020.111170.
41. Schanes, K., Dobernig, K., Gözet, B. (2018). Food waste matters – A systematic review of household food waste practices and their policy implications. *Journal of Cleaner Production*, *182*, 978-991, doi.org/10.1016/j.jclepro.2018.02.030.
42. Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., Saheb-Kashaf, M., Shi, P., Micha, R., Imamura, F. and Mozaffarian, D. (2019), Food PRICE (Policy Review and Intervention Cost-Effectiveness) Project. A Meta-Analysis of Food Labelling Effects on Consumer Diet Behaviors and Industry Practices. *American Journal of Preventive Medicine*, *56*(2), 300-314, doi: 10.1016/j.amepre.2018.09.024.
43. Sielicka-Różyńska, M., Jerzyk, E., Gluza, N. (2021). Consumer perception of packaging: An eye-tracking study of gluten-free cookies. *International Journal of Consumer Studies*, *45*(1), 14-27, doi: org/10.1111/ijcs.12600.
44. Stuart, S.A. (2010). The relationship between mandatory and other food label information. *British Food Journal, 112(1),* 21-31, doi: 10.1108/00070701011011173.
45. Sunstein, C.R. (2021). Viewpoint: Are food labels good? *Food Policy*, *99*, 101984. doi: 10.1016/j.foodpol.2020.101984.
46. Świda, J., Halagarda, M., Popek, S. (2018). Perceptions of older consumers regarding food packaging as a prerequisite for its improvement: A case study of Polish market. *International Journals of Consumer Studies*, *42*, 358-366, doi.org/10.1111/ijcs.12427.
47. Toma, L., Font, M.C., Thompson, B. (2020). Impact of consumers' understanding of date labelling on food waste behaviour. *Operational Research*, *20*, 543-560, doi: 10.1007/ s12351-017-0352-3.
48. United Nations (2015). *Resolution adopted by the General Assembly on 25 September 2015, 526 A/RES/70/1, Transforming our world: the 2030 Agenda for Sustainable Development, 527*. United Nations. Retrieved from https://undocs.org/en/A/RES/70/1, 28.07. 2020.
49. Ustawa o bezpieczeństwie żywności i żywienia (tekst jednolity) (Polish Act on Safety of Food and Nutrition), Dz.U. 2019, poz. 1252.
50. Van Boxstael, S., Devlieghere, F., Berkvens, D., Vermeulen, A., Uyttendaele, M. (2014). Understanding and attitude regarding the shelf life labels and dates on pre-packed food products by Belgian consumers. *Food Control*, *37*, 85-92, doi: 10.1016/j.foodcont. 2013.08.043.
51. van Geffen, L., van Herpen E., Sijtsema S., van Trijp H. (2020). Food waste as the consequence of competing motivations, lack of opportunities, and insufficient abilities. *Resources, Conservation & Recycling: X*, *5*, 100026, doi: 10.1016/j.rcrx.2019.100026.
52. Varallo C. (2013). *Written Q&A to EU Commission – Sale of food after 'use by' date or 'best before' date*. Retrieved from https://foodlawlatest.com/2013/10/23/written-qa-to-eu-commission-sale-of-food-after-use-by-date-or-best-before-date, 04.10.2021.

53. Vijaykumar, S., Lwin, M., Chao, J., Au, C. (2013). Determinants of food label use among supermarket shoppers: A Singaporean perspective. *Journal of Nutrition Education and Behavior*, *45*, 204-212. doi: 10.1016/j.jneb.2012.09.001.
54. Wikström, F., Williams, H., Verghese, K., Clune, S. (2014). The influence of packaging attributes on consumer behavior in food-packaging life cycle assessment studies – a neglected topic. *Journal of Cleaner Production, 73*, 100-108, doi: 10.1016/j.jclepro.2013.10.042.
55. Zielińska, D., Bilska, B., Marciniak-Łukasiak, K., Łepecka, A., Trząskowska, M., Neffe-Skocińska, K., Tomaszewska, M., Szydłowska, A., Kołożyn-Krajewska, D. (2020). Consumer understanding of the date of minimum durability of food in association with quality evaluation of food products after expiration. *International Journal of Environmental Research and Public Health*, *17*(5), 1632, doi:10.3390/ijerph17051632.
56. Zuschke, N. (2020). The impact of task complexity and task motivation on in-store marketing effectiveness: An eye tracking analysis. *Journal of Business Research*, *116*, 337-350, doi: 10.1016/j.jbusres.2020.05.009.