

# Food waste drivers in Croatian households

## Pokretači nastanka otpada od hrane u hrvatskim kućanstvima

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### Abstract

Many social and economic trends encourage food wastage at household level. These trends, coupled with wrong purchasing and cooking planning, inaccurate interpretation of expiry date, inadequate storage, and lack of knowledge on how to re-use leftovers, have led to households being the largest sector in food waste generation. The objective of this paper is to investigate how households everyday practices regarding food lead to food waste. A survey was conducted with the aim to identify management behaviours with food waste among Croatian population. Nearly half (48%) of the respondents reported that the main culprit in household food wastage was preparation of excessive amounts of food for meals, while, for one third of the respondents as a reason for occurrence of food waste was the purchasing of an excessive amount of food (28.5%). Respondents were also asked to assess what activities they conduct to reduce food waste in their households. Most respondents (34.8%) stated that they feed the dog or cat. Almost a third of the respondents (27.6%) discard leftovers from meal in the bin. Most of respondents consider food waste a financial loss (68.1%), and bad for the environment (63.1%), but majority (54.3%) discarding food when suspect it is unsafe.

**Keywords:** environment, food management behaviors, food waste, households, survey

### Sažetak

Mnogi socijalni i ekonomski trendovi potiču gubitak hrane na razini kućanstava. Ti trendovi, zajedno s pogreškama u planiranju kupovine i pripremi hrane, netočnoj interpretaciji datumskih oznaka upotrebljivosti hrane, neodgovarajućem skladištenju, kao i neznanju o iskoristivosti ostataka obroka, doveli su do toga da su kućanstva najveći pojedinačni sektor u proizvodnji otpada od hrane. Cilj rada je istražiti kako svakodnevne prakse u kućanstvima povezane s hranom dovode do otpada od hrane.

Provedeno je istraživanje s ciljem utvrđivanja ponašanja hrvatskog stanovništva u postupcima upravljanja hranom koji su povezani s otpadom od hrane. Gotovo polovica (48%) ispitanika navela je kako je glavni krivac za nastanak otpada od hrane u kućanstvima prevelika količina pripremljenog obroka, dok je za trećinu ispitanika na drugom mjestu razloga nastanka otpada od hrane prevelika količina kupljenih namirnica (28,5%). Od ispitanika je zatraženo i da procjene koje aktivnosti provode kako bi smanjili otpad od hrane u njihovim kućanstvima. Najviše ispitanika (34,8%) navelo je kako nahrani psa ili mačku. Gotovo trećina ispitanika (27,6%) baci preostalu hranu iz obroka u kantu za smeće. Većina ispitanika smatra kako je bacanje hrane financijski gubitak za kućanstvo (68,1%), negativno utječe na okoliš (63,1%) te da većinom bacaju hranu kada sumnjaju u njenu zdravstvenu ispravnost (54,3%).

**Ključne riječi:** anketa, kućanstva, navike u upravljanju hranom, okoliš, otpad od hrane

## Introduction

Food production is the main driver of global environmental change, because it uses 25% of the total habitable area and draws 70% of the world's drinking-water consumption, and is the major cause of land-use change (Croatian Environmental Agency, CEA, 2014). Nevertheless, every year one-third of the global food supply is lost or discarded (Food and Agriculture Organization, FAO, 2013). Food losses may occur at each stage of the supply chain, due to a variety of reasons and influenced by the actions of different actors, as well as situational factors (The Waste and Resources Action Programme, WRAP, 2015). At the level of production, losses in developed countries may occur due to poor weather conditions, sorting according to strict quality standards, and market prices that do not justify harvesting costs. In production and processing, losses can occur when washing, peeling, cutting and cooking, or when the products are put aside as unsuitable. In distribution, losses can occur due to packaging damage, non-compliance with security requirements, exceeding the shelf-life, inadequate inventory management, marketing strategies and logistics constraints. In the final consumption phase, losses are possible due to consumer preferences, wrong purchasing planning, inaccurate interpretation of expiry date, inadequate storage, preparing meals that are too large, and lack of knowledge on how to re-use leftovers (Institution of mechanical engineers, ImechE, 2013; High Level Panel of Experts on Food Security and Nutrition, HLPE, 2014).

Apart from these causes of food loss, there are social and economic trends that encourage food wastage, mainly at household level. This includes growing prosperity, food price reduction, urbanization, a rising number of single-person households, and increasing employment among women, as well as increasing burdens in professional and family life (Jörissen et al., 2015). One clear indicator of the creating of yet greater amounts of municipal solid waste, and thus food waste as well, is gross domestic product (GDP), as developed countries spend more. Therefore, reducing consumption impact, which would result in smaller quantities of waste produced, requires thorough changes in lifestyle and everyday consumer

behaviour. Based on the research and statistical calculations performed, it has been confirmed that, in developed countries, household sector contributes most to total food waste (Parfitt et al., 2010; Grethe et al., 2011; Monier et al., 2011; FAOSTAT, 2013; Bräutigam et al., 2014; WRAP, 2015).

Previous studies have confirmed that the main reasons for the generation of food waste in households are excessive purchasing (Koivupuro et al., 2012; Berreta et al., 2013; Ganglbauer et al., 2013; Porpino et al., 2015), then excessive preparation (Quested and Johnson, 2009; Koivupuro et al., 2012; Williams et al., 2012; Berreta et al., 2013; Porpino et al., 2015) and poor planning (Bell et al., 2011; Principato et al., 2015; Stefan et al., 2018). Despite the high level of attention given to this problem, as well as numerous initiatives within Member States, there are no reliable and comparable data at EU level as to how much food is discarded at different stages of production, distribution and consumption, partly due to inconsistencies in the definition of food waste and partly because of different methodologies of monitoring and reporting on quantities. In Croatia, there is also no data on the quantities of food waste produced, but only estimates on the amount of such waste, which is disposed of at landfill sites in residual municipal waste, and which, in the last few years, has amounted to about 380,000 tonnes per year (Croatian Agency for the Environment and Nature, CAEN, 2017).

Due to its highly adverse impact on the environment, as well as the fact that its volumes can be halved by a change in the consumption model, food waste is the most commonly targeted specific type of waste when planning preventive activities. In the last decade, Europe has made significant progress in diverting waste from landfills, and in 2012 EU member states achieved an average recycling rate of 37%, while in 2004 it amounted to 28% (European Environmental Agency, EEA, 2013). By comparison, the rate of recycling of municipal solid waste in Croatia in 2016 was 21%, equal to the rate of municipal waste recovery (CAEN, 2017). As with other types of waste, the basic European guideline for the establishment of a waste-management system or waste hierarchy is applied to food waste. According to the model of Papargyropoulou et al. (2014), adapted by Bonomi et al. (2016), the processes involved in reducing food waste should be at the top of the food waste management hierarchy. Food, even if it loses its commercial value, often retains its nutritional properties and has economic and social value, and needs to be treated accordingly, as shown in Table 1. Here it should point out the important difference between excess food that can be re-purposed and used as food for humans or animals, and the moment when this food becomes waste that gets recovered or recycled. It is also important to understand that not all organic food waste can be avoided, because some parts are not edible (e.g. eggshells, animal bones, stems, and the peel of certain fruit). Considering edible and non-edible food in accordance with Quested and Johnson (2009), food waste can be classified into three categories: avoidable food waste – waste that can be avoided because it entails discarded food that was, prior to being discarded, edible by everybody, but was then discarded mainly because it was no longer desirable; potentially avoidable food waste – waste that has great potential for avoiding its creation, encompassing food that some people consume and some do not, or which may or may not be edible, depending on how it is prepared (e.g. potato peelings, bread crumbs); and unavoidable food

waste – waste whose generation can not be avoided. It comes from food preparation and is not, nor ever has been, edible in normal circumstances.

Table 1. Food waste management hierarchy

Intervention area	Actions
Prevention	Avoiding the creation of food surplus in production and food consumption; Prevention of avoidable food wastage in the entire food-chain supply through education
Reuse	Reuse of food for human consumption through a redistribution network and food banks
Recycling	Recycling food waste into animal feed or compost
Recovery	Treatment of unavoidable food waste to get energy
Disposal	Waste management of unavoidable food waste into designed landfills, and exploitation of gases produced within the system

Source: Bononi et al., 2016

According to the food waste hierarchy, disposal is the least desirable solution, as waste from food at the landfill is turned into methane, a greenhouse gas with a global-warming potential 25 times higher than carbon dioxide. In addition, due to its composition, food waste is prone to faster decomposition than other organic materials. Therefore, reducing the amount of food waste at landfills in a resource-efficient system should be a priority (European Commission, EC, 2015).

Establishing an effective food waste management system is a necessity not only to protect the environment and make more efficient use of resources, but also for economic and social benefits. Since the social awareness and personal motivation of the population, with the existence of adequate infrastructure, have great impact on the efficiency of the food waste management system, the aim of this paper was to investigate the perception of the Croatian population with respect to the causes of food wastage and activities in regard of food waste, as well as their financial, environmental and health concerns relating to the possibility of reducing and collecting food waste.

## Materials and methods

The research was conducted from 25<sup>th</sup> September to 3<sup>rd</sup> October 2017. In collecting primary data, the direct method of telephone interviewing of individuals and the direct completion of a questionnaire was used. Telephone interviewing is the best method of rapid information gathering. The interviewer is able to clarify questions if the respondent does not understand them. The response rate is higher than in the case of a questionnaire sent through the mail. On the other hand, the disadvantage of a

telephone enquiry is that phone contact is less personal, the conversation has its own boundary, if the interviewees feel that the conversation is too long, they can simply terminate it; not all types of questions can be posed, and no additional aids can be used (Vranešević and Marušić, 2001).

For the purposes of the research, a deliberately disproportionate sample of 1,000 respondents was used, of whom 838 approached the research with a positive response to the eliminating question "Do you discard food waste?". Those respondents (162) responding negatively to the elimination question have not been considered in this research, which includes people of all age groups, in order better to investigate attitudes and approaches to food waste. In the analysis of the data collected, the statistical method of analysis by arithmetic medium was used, the collected data were analysed qualitatively and quantitatively, and an inductive-deductive method was used in drawing conclusions based on the research conducted. In addition to questions about attitudes, habits and food waste management, the questionnaire also collected demographic characteristics of the respondents (age, gender, place of residence). The research was conducted anonymously.

In formulating the theoretical part, a method of analysis and synthesis was used. The theoretical analysis was based on the foundation of relevant scientific and professional literature: the cognition of scientists and other authors who, in their articles and books, have explored the issue of municipal solid-waste management with an emphasis on food waste.

## Results and discussion

### Demographic characteristics of the respondents

The sample includes people of all age groups in order to determine the better quality of data and the respondents' attitudes towards managing food waste. The distribution of the sample is shown in Table 2. Of the 838 respondents, 433 (48.3%) were female and 405 (51.7%) male. The largest group is that of respondents between 18 and 30 years old (22.43%), while the smallest is of 61-to-70-year-olds and amounts to 13.13%. It is evident that the age groups are evenly distributed. The average male and female respondent was in the third age group of households investigated. Out of a total of 838 respondents, 543 (64.8%) reported living in an urban area, and 295 (35.2%) in a rural one. Furthermore, 324 respondents (38.7%) reported living in a flat, and 514 (61.3%) in a house.

The number of people living in the household was also determined. It is evident that the largest groups are of those respondents who live in a three-member household (188 respondents), four-member household (177) and two-member household (176). Only 11 respondents live in a household with more than six members. As the number of children is positively related to the amount of food being discarded, it was investigated how many children under 18 there are in the household. Thus 429 respondents reported that there were no children in the household, which amounts to the high proportion of 51.19% of the total number of respondents participating in this investigation. A further 191, or 22.8%, answered that there was one child in the

household; 162, or 19.33%, had two children; and only 56 respondents, or 6.68%, answered that they had more than three children.

Table 2. Description of respondents

Respodents	N	(%)
Gender		
M	405	48.3
F	433	51.7
Age		
18-30	188	22.43
31-40	125	14.92
41-50	149	17.78
51-60	145	17.3
61-70	110	13.13
>71	121	14.44
Location		
Urban	543	64.8
Rural	295	35.2
Unit		
House	514	61.3
Flat	324	38.7
Persons per household		
1	95	11.34
2	176	21
3	188	22.43
4	177	21.12
5	128	15.27
6	63	7.52
>7	11	1.32
Children per household		
0	429	51.19
1	191	22.79
2	162	19.33
3	53	6.32
4	3	0.35

The respondents included in survey were from all Croatian counties, taking into account the overall distribution of citizens according to the latest census of 2011 (Croatian Bureau of Statistics, CBS, 2013). Thus, the largest number of respondents was gathered in the City of Zagreb 16.5%, then Split-Dalmatia County 12.2%, Osijek-Baranja 8.4% and, finally, Lika-Senj County with 0.8% (Figure 1).

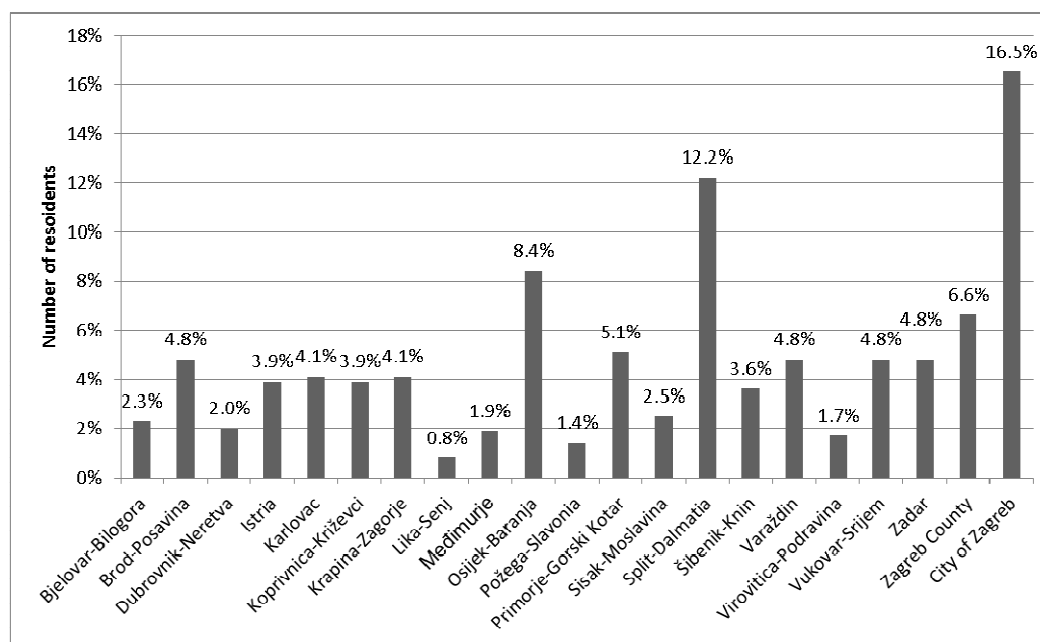


Figure 1. Distribution of respondents by county

### Reasons for food waste generation

Economic growth at the global level has led to an increase in global personal consumption, resulting in the destruction of the environment by overuse of natural resources (Chen and Chai, 2010). This same thesis is also confirmed as accurate in this study, too, where almost half of the respondents (48%) reported that the main culprit for food waste is too much food prepared, which, with too much food bought (28.5%), makes up most of the total amount of food waste. Therefore, it is necessary to give priority to the prevention of wastage as the most important and most advantageous method for dealing with waste problems, but which is often the most neglected one. Avoidance of waste, and reduction of its quantity, involves taking measures before a product becomes waste.

This reduces the amount of waste and avoids the harmful effects of waste on the human health and environment, as well as the content of harmful substances in materials and products. Preventive measures for successful food waste management should be carried out at any time and in every place (in production, distribution, sale, preparation and consumption).

Respondents of both sexes and all age groups, as well as of different places of residence, indicated that the main reason for discarding food in households is the preparation of excessive quantities for meals (Figure 2). This can be linked to a 'good

provider' role. In a research on Swiss consumers, Visschers et al. (2016) found that the 'good provider' role is one of the most important reasons for food wastage. This syndrome is associated with buying and preparing enough food, or more than enough, because one believes that in this way a person will take good care of family members and guests and satisfy all their tastes. Because of their desire to supply plenty of food to family members, people who are in the 'good provider' role, very often, simply can not reduce the proportion of food waste in their households, even though they want to. Research on English consumers also reports that minimizing food waste is fuelled by a desire to save money, but the motive of being a 'good provider', especially among mothers, has led to overpurchasing and consequently increased food wastage (Graham-Rowe et al., 2014).

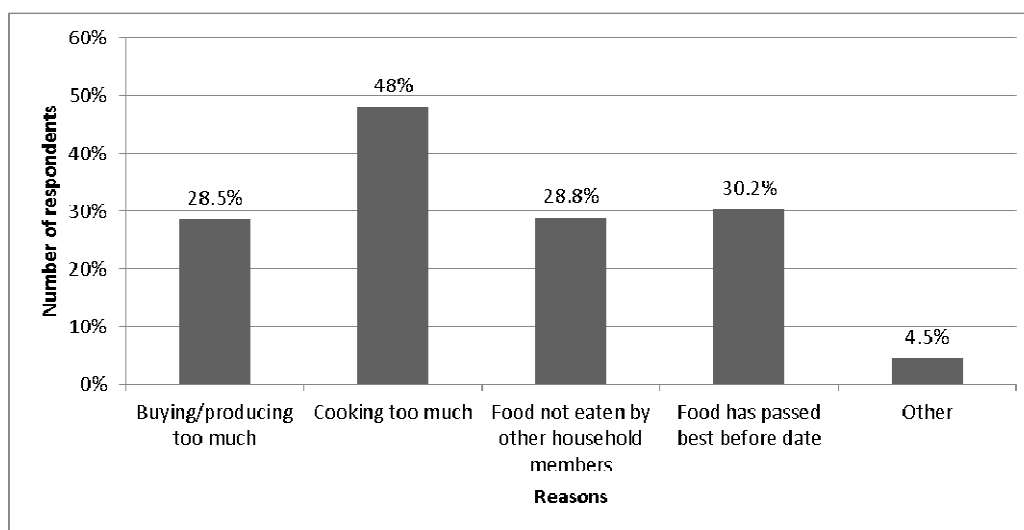


Figure 2. Respondents' answers on reasons for discarding food

Respondents' answers, by county, on reasons for discarding food, are listed in Table 3. The table shows that respondents from six counties answered differently from the state-level average. In Brod-Posavina County 42.37% of respondents, in Lika-Senj 33.33% and in Međimurje 43.14%, answered that the most common reason for food wastage was excessive purchasing or production of food. Only in two counties – Koprivnica-Križevci 35.29% and Sisak-Moslavina 27.73% – did respondents answer that the main culprit for generating food waste in their households is that members of the household do not eat their meal portions. Furthermore, in just one county, Virovitica-Podravina County, 37.93% of respondents reported forgetting food, and its consequent expiry, as the most common form of food wastage. Table 4 shows answers to the question of why food is wasted, by respondents' household size and number of children under 18.



Table 3. Answers of respondents on reasons for discarding food, by county

County	Buying / producing too much (%)	Cooking too much (%)	Food not eaten by other household members (%)	Food has passed best before date (%)	Other (%)
1	42.37	20.33	23.74	13.56	0
2	25	37.5	27.5	10	0
3	24.32	32.43	13.51	29.73	0
4	27.17	28.26	19.57	22.83	2.17
5	11.76	35.29	23.53	11.76	17.65
6	8.82	29.41	35.29	17.65	8.82
7	20.59	32.35	20.59	14.71	11.76
8	33.33	27.78	16.67	22.22	0
9	43.14	17.65	11.76	25.49	1.96
10	22.86	38.57	24.29	11.43	1.43
11	33.33	52.38	9.52	4.76	0
12	10.58	27.88	26.92	30.77	3.85
13	25.74	25.74	27.73	20.79	0
14	10.41	36.43	27.88	20.07	5.2
15	4.08	38.77	24.49	28.57	4.08
16	22.06	48.53	22.06	5.88	1.47
17	6.9	31.03	17.24	37.93	6.9
18	34.15	29.27	19.51	9.76	4.88
19	20.97	46.77	27.42	4.84	0
20	16.3	35.87	17.39	29.71	0.72
21	23.62	31.44	14.92	28.60	1.42

Key to counties: 1. Bjelovar-Bilogora, 2. Brod-Posavina, 3. Dubrovnik-Neretva, 4. Istria, 5. Karlovac, 6. Koprivnica-Križevci, 7. Krapina-Zagorje, 8. Lika-Senj, 9. Međimurje, 10. Osijek-Baranja, 11. Požega-Slavonia, 12. Primorje-Gorski Kotar, 13. Sisak-Moslavina, 14. Split-Dalmatia, 15. Šibenik-Knin, 16. Varaždin, 17. Virovitica-Podravina, 18. Vukovar-Srijem, 19. Zadar, 20. Zagreb County, 21. City of Zagreb

Table 4. Answers of respondents on reasons for discarding food, by number of members and children in the household

Respondents	Buying / producing too much (%)	Cooking too much (%)	Food not eaten by other household members (%)	Food has passed best before date (%)	Other (%)
Persons per household					
1	10.77	40	3.08	42.3	3.85
2	18.62	36.67	16.04	22.92	5.73
3	19.32	34.21	19.92	25.35	1.21
4	25.09	28.91	23.09	21.82	1.09
5	21.85	33.23	24.92	18.77	1.23
6	19.34	32.6	27.62	13.81	6.63
7	16.68	33.33	27.78	22.22	0
Children per household					
0	20.91	34.22	17.21	25.57	2.09
1	21.24	31.08	22.01	22.97	2.7
2	19.94	30.47	26.32	18.84	4.43
3	16.81	42.48	28.32	1.5	0.88
4	16.67	50	0	33.33	0

The problem of wrong assessment of the amount of food prepared, or the 'good provider' role, is confirmed as the most common cause of food wastage for all respondents who live in households with at least two or more household members, which can be linked to the number of family members, and the greater difficulty of satisfying the tastes of certain household members. This thesis is confirmed by the results of those who live on their own in households, where the most common cause of food wastage is that the respondents forget about the food so that its expiry date passes (42.3%). Nevertheless, in such households too, a very high percentage of respondents reported that the cooking of oversized meals is a frequent cause of food wastage. Children may be particularly picky about fruit, vegetables and meat (Dubois et al., 2006). However, it is interesting that none of the respondents who have four children stated, as a reason for the generation of food waste, that members of the household do not eat their meal portions, which can be associated with financial

concerns that often accompany excessive purchase and food preparation, with food being thrown away as a consequence. Financial concerns due to excessive purchases are often referred to as a factor that motivates consumers to reduce their food waste (Quested et al., 2013; Graham-Rowe et al., 2014). The amount of money spent on groceries seems to be related to the amount of food discarded, so households that spend more on food purchasing are larger waste producers than households with lower budgets for food (Parizeau et al., 2015). This leads to a positive correlation between the amount spent on food and the amount of food that is discarded in a household (Visschers et al., 2016). Similarly, it was found that consumers who were more or less aware of prices were discarding less food (Williams et al., 2012). The results of this study have shown that as many as 68% of respondents, regardless of sex, age and number of people or children in the household, believe that discarding food is a financial burden on the household (Figure 3), and Table 5 and 6 shows the results by county, number of household members, and number of children.

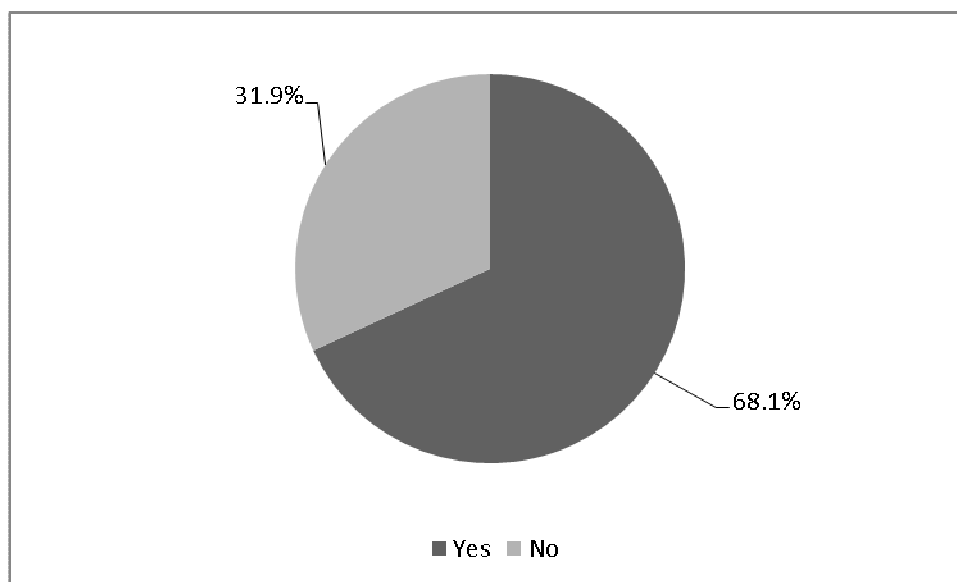


Figure 3. Financial concern related to food waste

Table 5. Answers of responses as to whether discarding food is a financial burden on the household, by counties

Respondents, by county	Yes (%)	No (%)
Bjelovar-Bilogora	88.13	11.87
Brod-Posavina	80	20
Dubrovnik-Neretva	72.97	27.02
Istria	78.26	21.74
Karlovac	82.35	17.65
Koprivnica-Križevci	79.41	20.59
Krapina-Zagorje	61.76	38.24
Lika-Senj	64.71	35.29
Međimurje	86.27	13.73
Osijek-Baranja	62.86	37.14
Požega-Slavonia	71.43	28.57
Primorje-Gorski Kotar	70.19	29.81
Sisak-Moslavina	81.19	18.81
Split-Dalmatia	62.83	37.17
Šibenik-Knin	57.14	42.86
Varaždin	73.53	26.47
Virovitica-Podravina	48.28	51.72
Vukovar-Srijem	55	45
Zadar	83.87	16.12
County of Zagreb	78.99	21.01
City of Zagreb	67.85	32.15

Table 6. Answers of responses as to whether discarding food is a financial burden on the household, by total numbers of person in households and number of children

Respondents	Yes (%)	No (%)
Persons per household		
1	65.38	34.62
2	64.18	35.81
3	76.86	23.14
4	69.82	30.18
5	74.15	25.85
6	73.48	26.52
7+	83.33	16.67
Children per household		
0	66.25	33.75
1	77.61	22.39
2	75.62	24.38
3	76.11	23.89
4	100	0

The results collected through answers from the respondents by number of people per household, shows notice the upward trend of positive statements as the number of people in the household increases. The lowest concern was found in respondents who are in a single-person or two-person household. Concern about finances when throwing food away, linked to rational usage of food, is most noticeable in respondents who have four children. All respondents responded that discarding food is a financial burden on the household, as well as 83.33% of respondents living in households with seven or more people.

The viewpoint of respondents in Virovitica-Podravina County is interesting: only there did the majority (51.72%) state that they believe that food waste is not a financial burden on the household. A very high percentage of such statements was recorded in the counties of Vukovar-Srijem (45%) and Šibenik-Knin (42.86%). Given the development of those counties and the composition of the respondents, who live predominantly in rural areas, such an attitude from the respondents can be interpreted as a view that, by using food waste in feeding domestic animals or by composting it, they do not discard food waste, but that they use it for another purpose. However, according to the definition of FUSIONS, the European Union project to establish monitoring, tracking and reporting on food waste in accordance

with a single methodology for all member states, food waste is any “food and inedible parts of food removed from the food supply chain to be recovered or disposed (including – composted, crops ploughed in/not harvested, anaerobic digestion, bio-energy production, co-generation, incineration, disposal to sewer, landfill or fish discarded to sea)” (FUSIONS, 2014). Therefore, all food that has exited the supply chain of human nutrition, and is not used for human consumption, becomes a loss, whether in the earlier stages of production and supply, or waste, or whether in the later phases of the chain, as in this case of food discard, caused by the actions of a consumer.

Food waste management is therefore dependent on the decisions of an individual, who, in everyday life, can make a choice between more or less eco-friendly behaviour, for which reason progressively more emphasis is placed on individual behaviours and household practices (Ebreo and Vining, 2001), as well as on strategies that promote individual and social behaviours with the aim of recycling, or on ‘socialization against waste’. In developed countries, since the 1980s, numerous investigations have been conducted on waste management and recycling, as well as on avoidance of waste. Results have shown that households participate in recycling primarily because of the belief that recycling is the personal responsibility of each individual, and in second place come positive attitudes towards recycling as one of the main ways of reducing pollution and preserving resources (De Coverly et al., 2008; Vincente and Reis, 2008; Stanić et al., 2009; Kalambura et al., 2016).

Respondents were asked to assess what activities they conduct to reduce food waste in their households. The highest number of respondents of both sexes, and of all age groups and places of residence, 34.8%, feed a dog or a cat, with the perception that such a practice with meal leftovers is not to be accounted for as discard of food, and 27.6% of the respondents store the remaining food in the freezer. Only 22.2% of respondents consume the surplus in the next meal, 12.9% use it for the preparation of a new meal, 18.7% of respondents compost food waste, and 14.3% feed it to domestic animals. Almost a third of the respondents (27.6%) discard left-over food in the bin without any further use. As Porpino (2016) established, consumers in a modern society tend to enjoy serving large portions of food, but at the same time are not always ready to re-purpose leftovers that remain on the table, for reasons that go beyond an inability to think up a new meal. It is therefore to be assumed that reasons for discarding food without any further use may imply a lack of knowledge about the reuse of meal leftovers or their proper keeping until the next meal, a lack of co-operation from other household members in avoiding food wastage, and squeamishness about eating meal leftovers. The distribution of responses is shown in Figure 4.

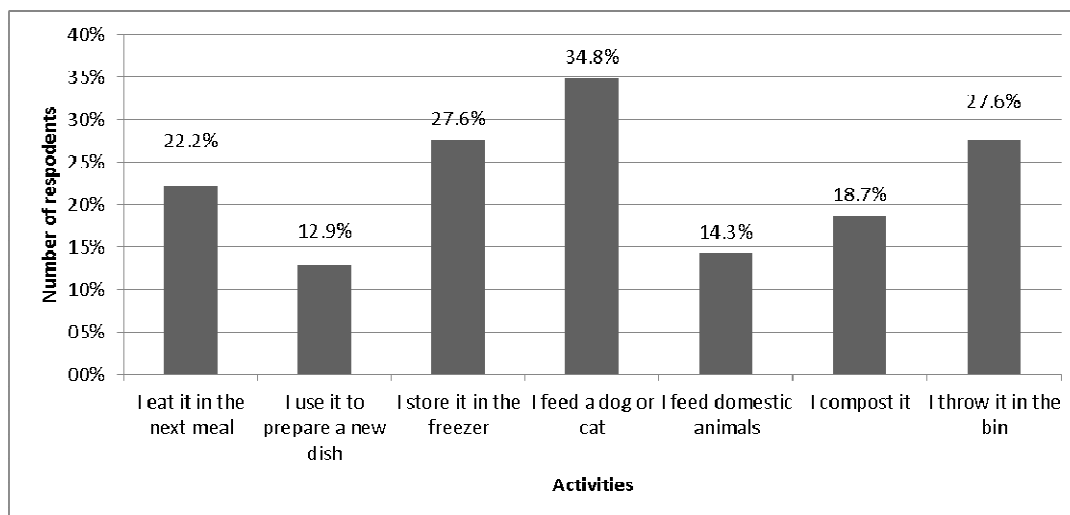


Figure 4. Overall results of respondents' answers as to food-waste procedures

Table 7 shows the respondents' answers as to food waste procedure, by number of person and number of children in the household. From the table it is apparent that, as the number of household members increases, the percentage of reports of discarding food into the bin decreases. While as many as 31.36% of respondents who live in a household on their own discard food into the bin, in households with six members only 2.65% do so, and 15.38% in households with seven or more members. Discarding food waste into the bin is the most common response for single-person households. An explanation for such behaviour may lie in the lifestyle of a single person, because such people often eat outside the home, and also in inappropriate retail packaging formats intended for more than one person, which, in the case of consumption in a single-person household, may lead to the discarding of food (Koivupuro et al., 2012; Joerissen et al., 2015).

The same trend is observed in households with only adult members, i.e. the number of reports of discarding food waste into the bin decreases as the number of children in the household increases. In families with four children only one report was recorded that uneaten food was discarded as rubbish. It can be assumed that parents, wishing to provide their children always with a large choice of food, also store meal leftovers more often in the refrigerator to preserve them for the next meal.

Table 7. Answers of responses on food waste procedure, by number of household and children in the respondent's household

Respondents	I eat at the next meal (%)	I use it to prepare a new dish (%)	I store it in the freezer (%)	I feed a dog or cat (%)	I feed domestic animals (%)	I compost it (%)	I throw it in the bin (%)
Persons per household							
1	12.71	7.63	12.71	22.03	7.63	5.93	31.36
2	9.23	10	18.08	18.08	9.23	11.56	23.85
3	16.67	8.16	20.41	23.81	5.78	12.24	12.93
4	19.33	5.83	15.36	24.23	5.52	10.12	19.63
5	11.54	20.88	23.08	18.13	10.44	11.54	4.4
6	12.39	6.19	10.62	21.24	34.51	12.39	2.65
7+	23.08	0	0	15.38	23.08	23.08	15.38
Children per household							
0	16.64	5.8	14.35	20.31	7.18	11.6	24.12
1	13.4	12.42	15.36	24.84	6.21	14.38	13.4
2	12.18	10.08	21.01	22.69	14.29	10.92	8.82
3	6.67	20	25.33	22.67	10.67	12	2.67
4	16.67	5.56	16.67	16.67	27.78	11.11	5.56

When analysing respondents' answers by county, shown in Table 8, it can conclude that, in the most of counties, the answer that prevails amongst respondents is that they feed meal leftovers to a dog or cat. In eight counties did the respondents state differently. Of concern was the data gained from answers by respondents in the City of Zagreb, where as many as 41.52% of them responded that they discard uneaten food into the bin. Such a high percentage of respondents reporting discarding food into the bin can be related to the fact that respondents in the City of Zagreb generally stated that they live in an urban area and that, accordingly, it is probably more difficult for them to process waste than it is for respondents in other counties. Only in three counties, that is Međimurje, Sisak-Moslavina and Varaždin, did the greatest number of respondents answer that they compost the leftovers. In Bjelovar-Bilogora and Zagreb County great number of respondents eat leftovers at the next meal in Križevci-Koprivnica respondents mainly feed domestic animals and in Karlovac county respondents mainly answered that they use leftovers for preparing a new dish.



Table 8. Respondents' answers on procedures regarding meal leftovers, by county

County	I eat at the next meal (%)	I use it to prepare a new dish (%)	I store it in the freezer (%)	I feed a dog or cat (%)	I feed domestic animals (%)	I compost it (%)	I throw it in the bin (%)
1	28.57	5.71	5.71	25.71	11.43	2.86	20
2	5	12.5	15	25	17.5	22.5	2.5
3	12.5	3.13	3.13	40.63	3.13	3.13	34.38
4	22.03	5.08	3.39	38.98	10.17	11.86	8.47
5	8.82	20.59	20.59	14.71	14.71	2.94	17.65
6	2.94	14.71	23.53	26.47	14.71	5.88	11.76
7	5.71	11.43	28.57	14.29	28.57	2.86	8.57
8	18.18	9.09	9.09	27.27	18.18	9.09	9.09
9	9.68	3.23	6.45	25.81	6.45	38.71	9.68
10	8.57	11.43	20	25.71	15.71	12.86	5.71
11	23.53	5.88	5.88	41.18	11.76	5.88	5.88
12	28.99	4.35	4.35	28.99	8.7	10.14	14.49
13	9.8	1.96	25.5	11.76	13.73	19.61	17.64
14	5.92	19.53	25.44	21.89	8.88	14.79	3.55
15	4.17	16.67	25	27.08	6.25	12.5	8.33
16	1.89	9.43	16.98	16.98	20.75	18.87	15.09
17	19.05	9.52	4.76	28.57	14.29	9.52	14.29
18	2.5	12.5	15	35	10	22.5	2.5
19	5.77	17.31	19.23	23.08	19.23	13.46	1.92
20	22.79	1.47	14.71	27.65	5.15	20.59	17.65
21	21.66	2.89	20.22	10.11	0	3.61	41.52

Key to counties: 1. Bjelovar-Bilogora, 2. Brod-Posavina, 3. Dubrovnik-Neretva, 4. Istria, 5. Karlovac, 6. Koprivnica-Križevci, 7. Krapina-Zagorje, 8. Lika-Senj, 9. Međimurje, 10. Osijek-Baranja, 11. Požega-Slavonia, 12. Primorje-Gorski Kotar, 13. Sisak-Moslavina, 14. Split-Dalmatia, 15. Šibenik-Knin, 16. Varaždin, 17. Virovitica-Podravina, 18. Vukovar-Srijem, 19. Zadar, 20. Zagreb County, 21. City of Zagreb

The whole system of food waste management is also based on the principle of a hierarchical concept in which there is the avoidance of waste at the top and, at the bottom, disposal at waste-disposal sites. A great deal of attention is given to the implementation of separate collection of waste, thus generating great savings of raw materials and energy sources. This is certainly the most important step in the overall waste-management system, since the segregation of valuable resources is thus being secured at the site of creation. Therefore, respondents were asked about the existing food waste management infrastructure in their town or unit of local self-government, i.e. it was necessary to determine whether separate collection and disposal of bio-waste was made possible for the respondents by the waste-management company. It is worrying that only 13.8% of respondents, regardless of whether they live in urban or rural areas, enjoy the organized collection of bio-waste by local waste-management companies, which reflects on the entire Republic of Croatia (Figure 5). According to the CAEN (2017), a total of 1,318,740 tonnes of municipal solid waste was disposed of in 2015, of which 828,564 tonnes was of biodegradable municipal solid waste (63%). The estimated quantities of bio-waste produced from municipal solid waste have not changed since 2012 and average about 530,000 tonnes. The proportion of bio-waste in residual municipal waste amounts to 37%, and is determined on the basis of the composition of the residual municipal waste. Taking into account this proportion and the amount of residual municipal waste disposed of, it can be concluded that 500,000 tonnes of bio-waste are disposed of at waste-disposal sites in the Republic of Croatia annually, of which about 380,000 tonnes is estimated to be food waste. On average, about 11% of the total bio-waste produced, or 60,000 tonnes, is collected separately, of which only half is passed on to recovery (composting, anaerobic fermentation). Separate collection of bio-waste in 2015 was carried out in 96 units of local self-government. Table 9 shows the respondents' answers to the question whether organized collection of bio-waste is provided at their place of residence by the waste-management company.

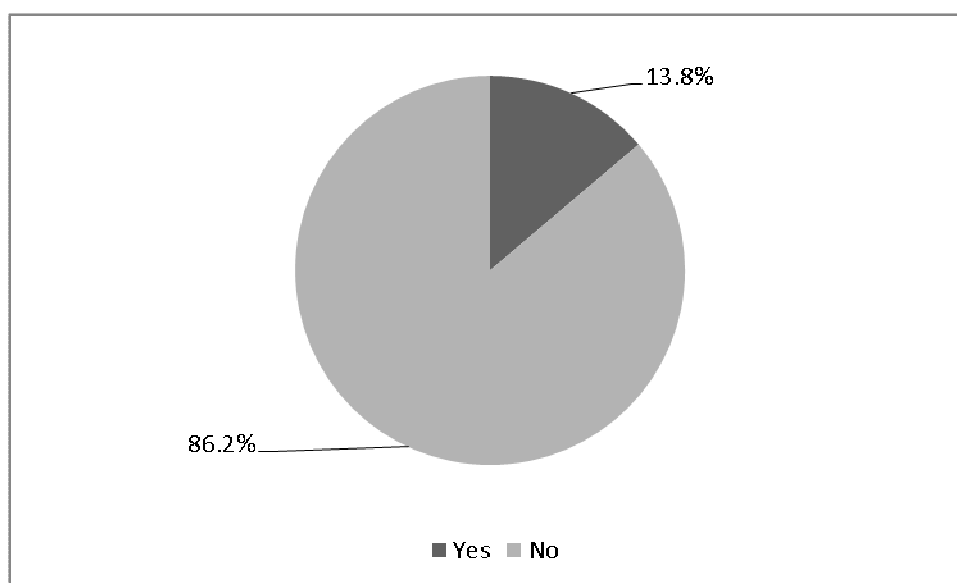


Figure 5. Respondents' answers to the question whether they have the organized collection of bio-waste

Table 9. Respondents' answers to the question whether they have the organized collection of bio-waste, by county

County	Yes (%)	No (%)
Bjelovar-Bilogora	0	100
Brod-Posavina	12.5	87.5
Dubrovnik-Neretva	0	100
Istria	8.7	91.3
Karlovac	38.24	61.76
Koprivnica-Križevci	47.06	52.94
Krapina-Zagorje	38.24	61.76
Lika-Senj	5.88	94.12
Međimurje	98.04	1.96
Osijek-Baranja	2.86	97.14
Požega-Slavonia	14.29	85.71
Primorje-Gorski Kotar	72.16	27.88
Sisak-Moslavina	32.67	67.33
Split-Dalmatia	0	100
Šibenik-Knin	0	100
Varaždin	0	100
Virovitica-Podravina	34.48	65.52
Vukovar-Srijem	0	100
Zadar	0	100
County of Zagreb	3.99	96.01
City of Zagreb	0.89	99.11

All respondents from the Dalmatian counties – Split-Dalmatia, Šibenik-Knin, Dubrovnik-Neretva and Zadar County – as well as the counties of Bjelovar-Bilogora, Varaždin and Vukovar-Srijem responded that there is no organized collection of bio-waste at their place of residence. The situation is no better in Zagreb County, Osijek-

Baranja and the City of Zagreb, where 96.01%, 97.14% and 99.11% of the respondents, respectively, reported that there was no organized collection of bio-waste by the waste-management company. Therefore, it is not surprising that, in counties where there is no organized collection of bio-waste, the highest percentage of statements was received from the respondents that they discard food waste into the bin, such as in the City of Zagreb 39.79%, Dubrovnik-Neretva 27.03% and Zagreb County 20.65%. Improper disposal of waste can be explained as a result of inadequate education and citizens' not being properly informed on the consequences of such a method of disposal, and that such a method of waste management prevents us exploiting all the valuable features, instead of their being disposed of in landfill.

Waste and inadequate waste management counts as one of the biggest pollution problems in the world today. The consequences of waste pollution are emissions into the air, water and soil, thereby endangering the quality of the environment, and the health of humans and other living organisms. Improper disposal (illegal dumps, release into components of the environment, etc.), quantities and properties of waste cause GHG emissions that affect change in the climate and the quality of water, air and soil, and which affect both flora and fauna, where introduction of pollution into the food chain results in the disappearance of sensitive species and in changes to habitat and the local growth of certain species. The waste-management system depends mostly on the everyday eco-(un)friendly behaviour of the individual. It is therefore necessary to investigate the relationship between the respondent and food waste as an ecological problem. Analysing the answer to the question of whether the discarding of food has an impact on the environment, the majority of respondents, regardless of sex and age group, responded positively to this claim. More precisely, 63.1% of the respondents confirm an attitude towards the harmfulness of discarding food into the environment (Figure 6).

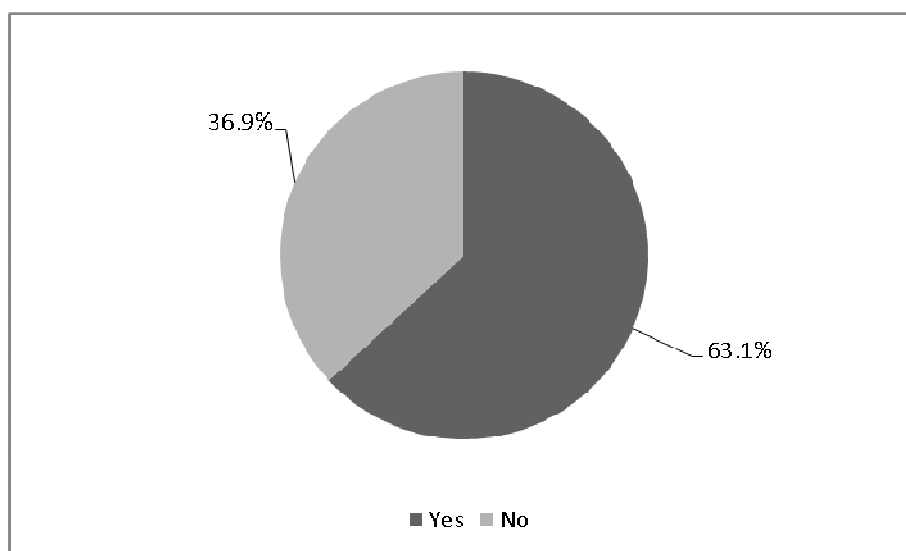


Figure 6. Attitude of the respondent to whether discarding food has an impact on the environment

Table 10 and 11 shows the results of answers from the respondents about their attitudes to the impact of discarding food into the environment, by county, size of household and number of children under 18.

Table 10. Respondents' answers as to whether discarding food has an impact on the environment, by county

Respondents, by county	Yes (%)	No (%)
Bjelovar-Bilogora	88.14	11.86
Brod-Posavina	45	55
Dubrovnik-Neretva	75.68	24.32
Istria	78.26	21.74
Karlovac	76.47	23.53
Koprivnica-Križevci	47.06	52.94
Krapina-Zagorje	61.76	38.24
Lika-Senj	52.94	47.06
Međimurje	78.43	21.57
Osijek-Baranja	34.29	65.71
Požega-Slavonia	76.19	23.81
Primorje-Gorski Kotar	78.85	12.15
Sisak-Moslavina	98.02	1.98
Split-Dalmatia	48.33	51.67
Šibenik-Knin	63.27	36.73
Varaždin	42.65	57.35
Virovitica-Podravina	86.21	13.79
Vukovar-Srijem	57.5	42.5
Zadar	48.39	51.61
County of Zagreb	82.61	17.39
City of Zagreb	84.9	15.1

Table 11. Respondents' answers as to whether discarding food has an impact on the environment, by total numbers of person in households and number of children

Respondents	Yes (%)	No (%)
Persons per household		
1	65.39	34.61
2	66.19	33.81
3	73.84	26.15
4	82	18
5	67.39	32.61
6	62.43	37.57
7+	72.22	27.88
Children per household		
0	73.86	26.14
1	76.06	23.94
2	67.31	32.69
3	55.75	44.25
4	83.33	16.67

This thesis was confirmed in all the respondents' households, regardless of number of children and household members. If the respondents are analysed by county, most of them also responded positively. No fewer than 98.02% of the respondents from Sisak-Moslavina County confirmed this attitude, whereby the respondents from that county showed high environmental awareness in the case of food being disposed of at waste-disposal sites. The City of Zagreb also showed a high level of positive response: no fewer than 84.9% of the respondents. In contrast, respondents from the counties of Osijek-Baranja (65.71%), Brod-Posavina (55%), Koprivnica-Križevci (52.94%), Varaždin (57.35%), Split-Dalmatia (51.67%) and Zadar (51.61%), mostly negatively rate the impact of discarded food on the environment.

Concerns about health are likely to increase the amount of perishable food waste such as meat, fish and dairy products. This is probably because the consumption of these products, when they turn rotten, is linked to a microbiological hazard whose consequences arouse fear. Figure 7 shows the results of the research regarding the respondents' concerns about health: that is, the response to the question whether they dispose of food when they suspect that it is hazardous to health. Almost 54.3% of respondents answered that they dispose of food when they suspect that it is hazardous to health. It is interesting that a difference between the years was also

found. Respondents of the older age group, over 71 years, are generally not worried about their health when consuming suspect products, and a high percentage of them (76%) do not dispose of food when they suspect it to be unsafe. This can be associated with extensive earlier experience of eating food beyond its use-by date, which did not result in a negative effect on their health.

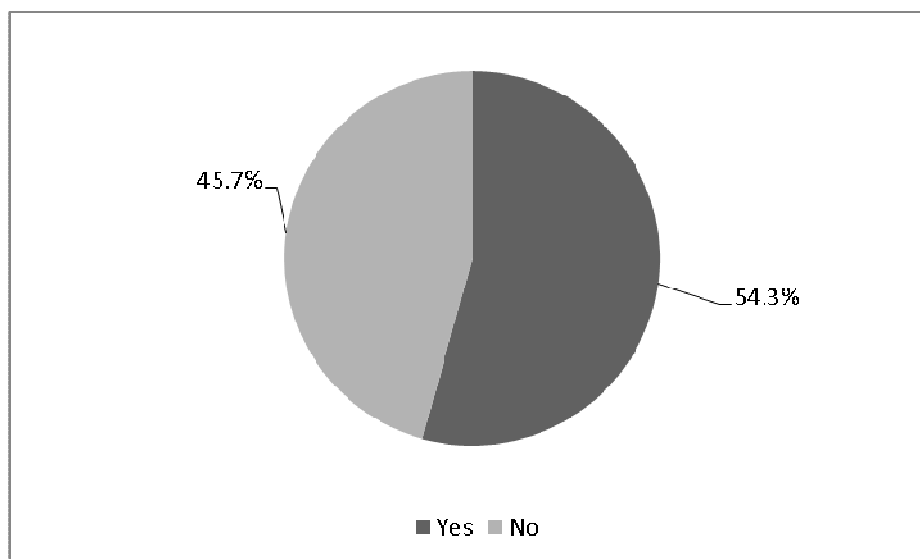


Figure 7. Respondents' answers on discarding food because they are uncertain of its safety

Tables 12 and 13 present the results of respondents' answers about discarding food in the case of concern for their health, by county, by household size, and by number of children under 18. In almost all households, a positive answer to the question was noted. Only respondents living in households with five members responded negatively, where most (54.46%) responded that, in general, they do not dispose of such foods. If the respondents are analysed by county, the majority also responded positively, except those from the counties of Sisak-Moslavina (76.24%), Zagreb (67.36%), Brod-Posavina (52.5%), Karlovac (52.94%), and Varaždin (50%), which had an equal number of either response from the respondents.

Table 12. Respondents' answers on discarding food when they were concerned about their health, by county

Respondents, by county	Yes (%)	No (%)
Bjelovar-Bilogora	54.24	45.76
Brod-Posavina	47.5	52.5
Dubrovnik-Neretva	67.57	32.43
Istria	73.91	26.09
Karlovac	47.06	52.94
Koprivnica-Križevci	52.94	47.06
Krapina-Zagorje	52.94	47.06
Lika-Senj	70.59	29.41
Međimurje	76.47	23.53
Osijek-Baranja	58.57	41.43
Požega-Slavonia	80.95	19.05
Primorje-Gorski Kotar	67.31	32.69
Sisak-Moslavina	23.76	76.24
Split-Dalmatia	54.28	45.72
Šibenik-Knin	59.18	40.81
Varaždin	50	50
Virovitica-Podravina	86.21	13.79
Vukovar-Srijem	55	45
Zadar	82.26	17.74
County of Zagreb	32.61	67.39
City of Zagreb	58.26	41.74



Table 13. Respondents' answers on discarding food when they were concerned about their health, by total numbers of person in households and number of children

Respondents	Yes (%)	No (%)
Persons per household		
1	63.08	36.92
2	59.31	40.69
3	52.11	47.89
4	54.73	45.27
5	45.54	54.46
6	65.75	34.25
>7	55.56	44.44
Children per household		
0	50.29	49.71
1	61.39	38.61
2	57.34	42.66
3	58.41	41.59
4	66.67	33.33

Date labels on food are often misunderstood by the consumer. Recently, the consumer research on EU market (EU, 2015) has shown that only a third of consumers understand or differentiate meaning of labels. To reduce the uncertainty of consumers regarding food edibility and provide accurate information to the public The European Parliament in its resolution of 19 January 2012 requested from: "the Commission and the Member States [...] to clarify the meaning of date labels ("best before", "expiry date" and "use by"), and in particular the understanding that minimum durability date "best before" refers to the quality, while the use of date "use by" relates to security, in order to facilitate consumers informed choices". Figure 8 shows the results of the survey conducted on the knowledge of respondents between the date of "use by" and "best before". The consumers' recognition and differentiation between these two date labels were tested. According to the mean value, it can be concluded that out of the total 838 subjects, even 36.8% of them, or 308 respondents, do not understand the label on food packaging.

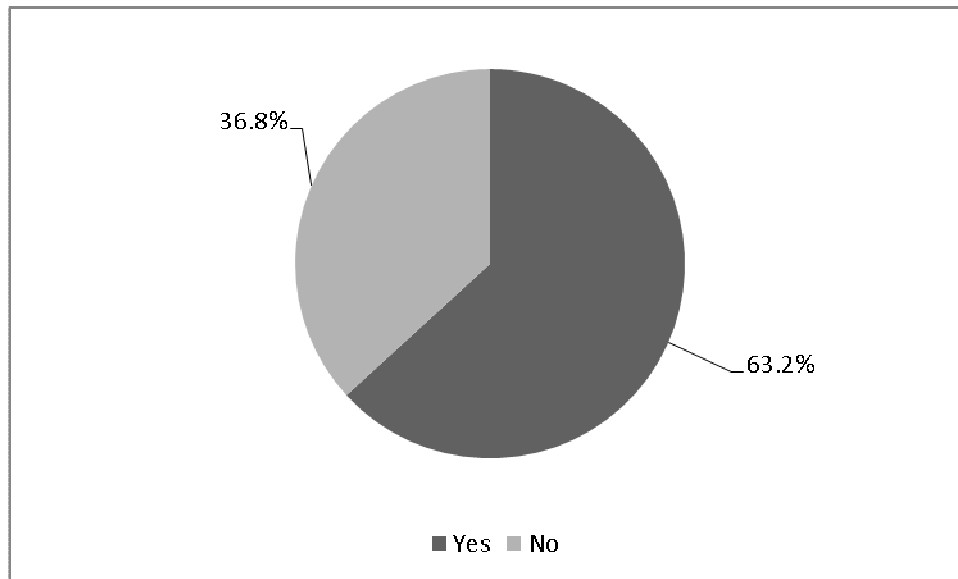


Figure 8. Knowledge of the difference between 'use by' and 'best before' dates amongst respondents

Interestingly, the only difference between respondents was found in the last two age groups, of 61-70 and over 71, where most respondents, regardless of gender and place of residence, do not know the difference between "use by" and "best before". More precisely, 52.1% of the respondents in the 61-70 age group, and 77.5% of the respondents aged over 71, gave negative responses to this statement. This confusion, especially among older respondents, is due to the fact that this information is not clear enough to consumers. Similarly, no fewer than 43.54% of respondents from rural areas did not know the difference between these two statements, while amongst respondents in urban areas this percentage is slightly lower and amounts to 32.9%. It is evident that the respondents do not recognize these differences, i.e. they do not know that 'use by' dates on food products do not necessarily mean that the product has gone bad overnight, but that the producer does not guarantee the product to be safe for health after that date. So some products are not dangerous to consume after the date given, but retailers are not allowed to sell them, nor consumers to buy them, because the lawgivers have so ordered.

Table 14 and 15 shows the results of respondents' answers about knowledge between the 'use by' and 'best before' dates. In almost all consumers a confirmatory response to the knowledge of these dates was recorded, except in households with several members, where respondents reported indecisively (50%). The greatest negative response to knowledge of these terms was observed in the county of Dubrovnik-Neretva, where as many as 86.49% of the respondents stated that they did not know the difference between these terms. Respondents from the Lika-Senj (52.94%), Požega-Slavonia (52.94) and Brod-Posavina (52.5%) counties also gave negative responses.

Table 14. Knowledge of the difference between 'use by' and 'best before' dates amongst respondents, by county

Respondents, by county	Yes (%)	No (%)
Bjelovar-Bilogora	71.19	28.81
Brod-Posavina	47.5	52.5
Dubrovnik-Neretva	13.51	86.49
Istria	57.61	42.39
Karlovac	61.76	38.26
Koprivnica-Križevci	61.76	38.24
Krapina-Zagorje	61.76	38.24
Lika-Senj	47.06	52.94
Međimurje	58.24	37.25
Osijek-Baranja	62.86	41.43
Požega-Slavonia	47.62	52.38
Primorje-Gorski Kotar	58.65	41.35
Sisak-Moslavina	75.25	24.75
Split-Dalmatia	72.12	27.88
Šibenik-Knin	71.43	28.57
Varaždin	61.76	38.24
Virovitica-Podravina	55.17	44.83
Vukovar-Srijem	77.5	22.5
Zadar	59.68	40.32
County of Zagreb	78.26	21.74
City of Zagreb	71.4	28.6

Table 15. Knowledge of the difference between 'use by' and 'best before' dates amongst respondents, by total numbers of person in households and number of children

Respondents	Yes (%)	No (%)
Persons per household		
1	63.08	36.92
2	66.76	33.24
3	72.63	27.36
4	67.64	32.36
5	75.69	24.31
6	62.43	37.57
>7	50	50
Children per household		
0	61.98	38.02
1	74.9	25.1
2	69.25	30.75
3	79.65	20.35
4	66.67	33.33

## Conclusions

Taking into account that a negligible 11% of the amount of bio-waste produced is separately collected – that is, 60,000 tonnes, half of which is sent for further processing – it is clear that the system must radically be reordered and improved following the European waste hierarchy, and it is especially important to start implementing activities to prevent this type of waste.

Since research results have shown, in some respondents, a high degree of lack of understanding of what food waste represents from the financial and environmental aspects, it is necessary to carry out systematic education of the Croatian population in order to prevent the creation of food waste, and to understand the processes of its further exploitation.

The necessity of education is also supported by the fact that a high percentage of respondents, especially among the elderly population, do not understand expiry-date labels. For this reason, a high number of respondents discard food when in the slightest doubt that it is safe to eat, although food, even when it loses its commercial value, often retains nutritional properties and has economic and social value.

Given the above, food wastage is best viewed not as an individual behaviour but as a consequence of multiple behaviours that can increase the likelihood of food loss, or its amount. These behaviours relate to many different aspects of the purchase and use of food through households from planning, buying and storing, to preparing and consuming food, which implies that, when food is discarded, the opportunity to prevent food from becoming waste has already passed. Therefore, activities should focus on educating consumers of all ages, focusing on the ways and methods of preventing food wastage at the level of the consumer, which is the largest individual sector in the production of this type of waste.

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