



Household food waste - consumer intentions and capacities for further reduction considering different food waste categories

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ABSTRACT

Recently, EU legislation has addressed Sustainable Development Goal 12.3, introducing legally binding targets for the Member States for the reduction of food waste across sectors by 2030 compared to 2020 levels. The mandatory reduction target is 30 % in retail and consumption levels (including households), and 10 % in the processing and manufacturing sectors. The current study includes household food waste data from 282 voluntary households in 2021. Data was collected by following a diary-supported direct food waste measurement methodology (FUSIONS methodology), completed by pre- and post-study questionnaire surveys with one respondent from each household. Avoidable (edible) food waste dropped by 23.99 % (from 33.14 kg/capita/year to 25.19 kg/capita/year) between 2016 and 2021. The reduction of total FW was only 3.73 % (68.04 kg/capita/year in 2016 and 65.50 kg/capita/year in 2021). Possibilities for further FW reduction in Hungarian households were investigated. This study found that 84 % of the households underestimated their actual total FW generation, and the average level of underestimation was 48.5 %. Research data suggests that unavoidable FW is not perceived to be wastage by the respondents. According to post-study questionnaire results, 77 % of the respondents believe they can further reduce the FW in their households. The finding suggests that, despite the decrease in household food waste from 2016 to 2021, there is considerable potential for further reduction, especially in the avoidable category. This potential is in line with broader goals of reducing food waste in households, contributing to national and EU targets for sustainable resource management and food waste reduction.

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1. Introduction

The issue of food loss and waste has gained significant attention in the last two decades, as shown by the substantial amount of research papers (Oláh et al., 2022; Bretter et al., 2022, 2023a, 2023b; Tan et al., 2022; Tonini et al., 2023; Vittuari et al., 2023) as well as many national and international efforts conducted and implemented to address this problem (FAO, 2019; Candéal et al., 2023). This occurrence is feasible due to documented reports indicating that on the global scale, around 20–50 % of the total world food production is wasted, and it has a significantly adverse influence on the economy, society, public health, and the environment (Bijos et al., 2022; Brás et al., 2022; FAO, 2011; FAO, 2015; Friege et al., 2021; UNEP, 2024; Lipinski, 2022; Obuobi et al., 2023). According to the United Nations Environment Programme (UNEP), the majority of total FW, around 60 %, originates from households, followed by 27.5 % from food services and 12.5 % from retail establishments (UNEP, 2024). Based on the available data, the current estimates indicate that over 59 million tons of food waste (FW) are generated in the European Union (EU) per year, and households are the main contributors, accounting for around 54 % of the total; and which correspond to an average of 72 kg of FW per person in 2021 (EUROSTAT, 2024). These data clearly show and point out that households account for a significant proportion of the FW problem (Kim et al., 2020). Hence, a more comprehensive examination is required of the capacity of consumers towards FW reduction and their inclination to actively participate in efforts aimed at mitigation.

With growing recognition that households play an essential role in FW, several reduction initiatives have emerged, generally focusing on households (denBoer et al., 2023; Think Eat Save, 2013; Szakos et al., 2021; WASTELESS, 2022). The Think. Eat.Save campaign is among the earliest efforts aimed at raising awareness about the impact of FW (Think Eat Save, 2013). Another early initiative focused on raising awareness about FW is the "Love Food Hate Waste" campaign, which was implemented by WRAP in the United Kingdom (UK) (WRAP, 2014). The Waste Framework Directive (2008/98/EC) is one of the first measures undertaken inside the European Union to tackle the issue of FW (European Parliament and the Council of the European Union, 2008). The issue of FW remains prominent within the EU and is still developing as a policy agenda (European Citizens' Panel, 2023; European Commission, 2023a). The modified Waste Framework Directive (2008/98/EC) obliges Member States to monitor the generation of FW and to take measures to limit its generation (European Commission, 2019; European Parliament and the Council of the European Union, 2008). In this regard, national initiatives such as Hungary's Project Wasteless (Maradék nélkül); France's Loi Garot; The Netherlands United Against FW among others, have been implemented to mitigate household food waste (HFW) generation (Bodiguel, 2021; Holzer and vanSeeters, 2018; Szabó-Bódi et al., 2018).

Furthermore, it has been argued that the results of these initiatives have varied due to the intricate complexity of the underlying reasons for FW at the household level, which may be attributed to psychological, socio-cultural, and economic factors (Kritikou et al., 2021; Vittuari et al., 2023). Consumer attitudes towards food, as well as their food purchase planning, food storage practices, and serving behaviors, have been identified as factors that might impact both the probability and amount of FW (WRAP, 2014; Ananda et al., 2021; Begho and Fadare, 2023; Chheang et al., 2023; Janssen et al., 2017). However, consumers tend to downplay the significance of their role in the FW generation because they believe their habits do not influence the broader picture (Bogevska et al., 2022; Jörissen et al., 2015). As a result, consumer feedback about the FW they generate in relation to empirical FW data represents a suitable approach for effectively delivering campaign information to consumers.

Concerning the UN Sustainable Development Goal (SDG) 12.3, which calls for a 50 % reduction of FW at the consumer level by 2030, the EU is currently still debating how to establish EU-level legal objectives (European Environmental Bureau, 2022). One of the reasons is that the UN target indicators are believed to be too ambitious, and frustration about not reaching it might backfire and ultimately slow progress toward SDG 12.3 beyond the potential (Lipinski, 2022). While several Member States of the EU, including Austria, Finland, France, Germany, Hungary, Spain, and the Netherlands, have already made significant steps in effectively decreasing FW (European Commission, 2019, 2021, 2022; Oláh et al., 2022; Szabó-Bódi et al., 2018), the EU's general potential in reaching the original SDG 12.3 goals is questioned. As a realistic but still ambitious goal, the European Commission proposed legally binding target indicators: a reduction of 30 % in retail and consumption sectors and a reduction of 10 % in processing and manufacturing sectors, both to be achieved by the year 2030, compared to the baseline year, which is yet to be agreed by member states and EU policymakers (European Commission, 2023b). To the best of the author's knowledge, there is limited research addressing the EU's newly proposed legally binding target, especially regarding the household perception and capability regarding decreasing FW in Hungary (Kasza et al., 2020; Kunszabó et al., 2022; Szabó-Bódi et al., 2018). In order to support this new development of these regulations, this work aims to assess and investigate the potential for households to reduce their FW further.

The key terminology used in this study consists of three main elements: FW, avoidable FW and unavoidable FW. Further explanations and definitions have been included in the Methodology section.

In Hungary, avoidable (edible) FW reduction was measured to drop by 23.99 % from 33.14 kg/capita/year to 5.19 kg/capita/year between 2016 and 2021 (Nébih, 2022). At the same time, a reduction of total FW by only 3.73 % was observed during the same period (from 68.04 kg/capita/year in 2016 to 65.05 kg/capita/year in 2021). This research will attempt to investigate the self-perceived capacity of Hungarian consumers to further reduce their own household FW. The results are expected to assist the European Commission's decision-making and are also essential to establish an argument in the national FW reduction campaign targeting citizens' ability to mitigate FW (Abeliotis et al., 2014; Szakos et al., 2021).

2. Literature review

Though many actions have been taken towards tackling FW (Aloysius et al., 2023; Cooper et al., 2023; Rooijen et al., 2024; Vittuari

et al., 2023), the situation continues to be the same, and it is still recognized as an important global problem (Etim et al., 2024; Islam et al., 2024; Pocol et al., 2020; Srivastava et al., 2023). The EU Member States have made significant efforts to reduce FW by creating massive actions, which correspond to SDG 12.3 (European Commission, 2023a). Therefore, legally binding targets for FW reduction across several sectors have been set so that FW reduction in the EU is projected to be more measured, targeted, and also increasingly achievable (European Commission, n.d.).

FW in Hungary is also a major concern, which the authorities and researchers are trying to address through various measures (Keller and Gombos, 2025; Kunszabó et al., 2022; Szabó-Bódi et al., 2018; Szakos et al., 2021). The Hungarian authorities have developed a number of innovative strategies, such as consumer awareness and educational campaigns, within the scope of Project Wasteless, the national FW prevention program of Hungary (Szakos et al., 2021; WASTELESS, n.d.). Several studies have also shown that the practice of the Wasteless project has been very successful in reducing FW (Kasza et al., 2020; Szabó-Bódi et al., 2018; Szakos et al., 2021). In 2016, the total FW was about 68.04kg/capita/year in Hungarian households and fell to 65.50kg/capita/year in 2021 (WASTELESS, 2023). To achieve the targets of SDG 12.3, Hungary is taking steps to minimize FW; however, they require additional help to reach their goals. Additionally, “SDG target 12.3 on food loss and waste: 2022 progress report” also indicates that many countries have not been successful and active in managing and reducing FW (Lipinski, 2022). Following an assessment to support the SDG 12.3 targets, the percentage of FW reduction, including reduction at the consumer level, has changed from 50 % to 30 % (European Commission, n.d.). This reduction in the waste reduction target was also carried out to maximize their actions to decrease the FW equivalent to the SDG 12.3 target and lower any potential that could slow down progress (Lipinski, 2022).

Distinguishing between avoidable and unavoidable FW is crucial for designing targeted policies and interventions aimed at reducing FW, particularly in the context of achieving SDG 12.3 (Shaw et al., 2018; Young et al., 2017; Leverenz et al., 2019). By focusing on avoidable FW, efforts can be more effectively directed toward practices and sectors where meaningful reductions are possible. However, one of the challenges in FW prevention is consumers' tendency not to be fully aware of their household practices and, thereby, underestimating the amount of FW they generate (Ahmed et al., 2021; Jörisen et al., 2015; Qusted et al., 2013; vanHerpen et al., 2019). Even individuals with high environmental awareness often report generating less waste than they actually do, as shown by Jörisen et al. (2015), which could limit the impact of awareness-raising initiatives. Similarly, van Dooren et al. (2019) found that consumer surveys relying solely on self-reported waste disposal frequency also led to significant underestimation. These misperceptions highlight the need for direct measurements and comparative studies to bridge the gap between perceived and actual FW, ultimately enhancing the effectiveness of national prevention campaigns.

With the new proposed legally enforceable targets for EU Member States to decrease FW across multiple sectors by 2030 compared to 2020 levels (European Commission, n.d.), this study intends to analyze consumer intentions and capacities for further reduction in more depth, considering diverse FW categories. This study will concentrate on consumer intentions and capacity for further reduction in view of several FW categories. The findings from this study are expected to provide a platform for developing more successful measures to drive FW reduction at the consumer level while also aiding the attainment of the targets established by the European Union.

3. Materials and methods

3.1. Survey and data collection

This study was based on the findings derived from a voluntary survey conducted in Hungary between November 3 and December 18, 2021. A total of 282 households have successfully accomplished the one-week measurement practice. Direct measurement of FW was assisted with a diary, according to the guidelines outlined by FUSIONS and the recommendations set out in (EU) 2019/1597 (Kasza et al., 2020; Szabó-Bódi et al., 2018). Diaries had been prepared and offered to households in two versions: online and printed. Instruments for measuring HFW, including a digital kitchen scale with precision in grams and a measurement jug, were also provided to the households. An information sheet, including a precise definition of the difference between avoidable, unavoidable, and potentially avoidable FW, was part of the package as well. According to our definition – consistent with the EU Waste Framework Directive (2008/98/EC) – FW means all food that has become waste. This encompasses any material not intended to be ingested by humans, but comprises an integral part of food (e.g. chicken bone, spent coffee grounds). Although, according to the definitional framework of the EU, food discarded via the sewer or given to animals is not considered as FW, the current measurement methodology also includes these material streams. Avoidable FW consists of any food material that was originally intended for human consumption, but due to any reason (lack of awareness, knowledge, or time management), it is discarded (e.g., mouldy bread, spoiled yogurt). Unavoidable FW is the inedible fraction generated mostly by processing raw materials (e.g., inedible fruit and vegetable peels, eggshells, used coffee grounds). Potentially avoidable FW consists of edible food parts that are not eaten due to specific health conditions (e.g., digestive disorders, cardio-vascular diseases, jaw, and teeth problems) or individual taste (e.g. disgust about cooked chicken skin).

The data collection approach for HFW spans a duration of one week, which has been determined as an adequate timeframe for discerning patterns in FW disposal practices within households (Kasza et al., 2020). Researchers operated a hotline for the respondents (phone, email, and Messenger) to reduce measurement biases during data collection. Continuous communication with the respondents was found to be a strong motivation factor for completing the one-week measurement period. Instances when data collection was limited to a single day or the occurrence of significant data gaps within the one-week period disqualified the household from participating in this research.

Besides the physical FW measurement, pre- and post-study questionnaire surveys were also conducted with the respondents,

incorporating open-ended, close-ended, and Likert-scale questions concerning consumer knowledge, attitudes, and perceptions of FW. The selection of questions utilized in this study is derived from prior research on the topic of FW (Kasza et al., 2020; Kunszabó et al., 2022; Oláh et al., 2022; Szakos et al., 2021; Vittuari et al., 2023). The person responsible for food purchases in each household was asked to complete this questionnaire. Besides demographic questions, the surveys aimed to acquire information on consumer opinions and an assessment of the annual quantity of FW generated in their households and their self-perceived potential to mitigate FW. The respondents were also asked to compare the amount of FW generated in their households to the average in Hungary, using a 5-point Likert scale (1 = far below the average, 3 = average, 5 = far above the average).

3.2. Statistical analysis

The relationship between consumer opinions on the potential for mitigating FW in alignment with the SDGs has been analysed by using statistical methods, including the Kruskal-Wallis test. Kruskal-Wallis was selected because it supports comparison among groups with varying dependent variables depending on the topics (Hecke, 2012; Sherwani et al., 2021; Soltani et al., 2017; Wong and Wong, 2016). Also, this test is often used by researchers to facilitate the process of decision-making (Sherwani et al., 2021). The data was analysed using STATA 14 software.

3.3. Sample description

This study guaranteed that all processes fulfilled the accepted criteria for validity since it followed the approach advised by the EU. Households in the study had complete voluntary participation; they could register using the form the National Food Chain Safety Office of Hungary (Nébih) distributed via a press release. Furthermore, the University of Veterinary Medicine Budapest approved the study ethically, therefore guaranteeing that, in terms of participant rights and data processing, all facets of the study followed ethical guidelines.

To promote this research and increase participation, a media campaign was conducted across several channels, such as television, social media platforms (Facebook and Instagram), the project website (maradeknelkul.hu), and the official website of the Nébih (nebih.gov.hu). Prior to data collection, respondents were informed about the research topic, the objectives of the study, the methods used to ensure the confidentiality of their responses and the subsequent analysis, and their rights to revoke their permission. A final sample size of 282 households was gathered, which represented 758 consumers. Table 1 presents an overview of the demographic characteristics of the sample.

4. Results and discussion

4.1. Descriptive analysis

The present study employs descriptive statistical analysis to substantiate the significance of mitigating FW by considering various elements such as socio-demographic characteristics, actual levels of FW production (total, avoidable, and unavoidable), and household opinions towards their ability to reduce FW and their perception of their own FW production. Also, the descriptive analysis provides an explanation of the variables used in the Kruskal-Wallis test. Further information on the variables included in this investigation and the quantity of the FW categories are presented in Tables 2 and 3.

Table 1
Socio-demographic composition of the sample (n = 282).

Variable	Description	Sample (%)
Gender of the responsible person for food purchasing in the household	Woman	83.69
	Man	16.31
Age (responsible person for food purchasing)	18–29	12.41
	30–39	25.89
	40–59	48.93
	60 and above	12.77
Geographical location	Capital city (Budapest)	19.50
	Other Cities	52.13
	Village	28.37
Household size	1	15.24
	2	35.11
	3	25.18
	4	17.38
	5 and above	7.09
Average household size	2.69	

Source: Own data collection

4.2. Relationship between actual FW and household perception of the FW level

FW at the consumer level is mostly attributed to consumer behaviour, which is inherently shaped by consumer perceptions and opinions (Zhang et al., 2020). To aid attempts to minimize FW, it is essential to investigate these underlying roots (Fanelli, 2019). Thus, this study aimed to investigate Hungarian consumers' perception and estimation regarding FW, whether it was considerably below or far above the average. As described in the methodology section, the study also investigated potentially avoidable FW; however, this part of the study has not been included in the comparative analysis of this paper, given its relatively small proportion (7.02 %) of the total FW.

Based on the findings, around 70.71 % of the respondents hold the belief that their production of HFW falls below the average in Hungary. This perception may be impacted by psychological factors, such as personal views on FW (Thi et al., 2022). Approximately 21.43 % of the respondents believe that they generate HFW on average, and 7.86 % believe they produce HFW above average (Fig. 1). Studies suggest that FW reduction and prevention are more likely among individuals who view FW as "wrong or bad" and experience feeling guilt when discarding foods (Quested et al., 2013; Visschers et al., 2016). Additionally, those who have a sense of responsibility or believe that reducing FW is right are motivated to reduce their waste (Graham-rowe et al., 2014). The finding that most respondents report their FW to be below the average highlights a generally positive perception of the importance of addressing FW among them.

Additionally, Fig. 2 provides a deeper insight into the differences between the perceived level and actual amount of FW in Hungarian households, in terms of the three FW categories considered in this research (total, avoidable, and unavoidable). Upon closer examination of the spread of the data between groups depicted in Fig. 2, a significant difference can be detected between the perception categories from 1 (far below the average) and 5 (far above the average), regarding the actual level of avoidable FW. This suggests that households that are less wasteful in terms of the avoidable category consider themselves as generating less FW (i.e. consumer perception is correct in this regard). The total FW has a similar pattern to avoidable FW, but with slight differences in the median and dispersion across different categories. At the same time, this phenomenon is not visible in the unavoidable category, suggesting that the generation of avoidable FW has a significantly higher impact on consumer perception. This might drive the conclusion that unavoidable FW is not perceived as FW (in the meaning of wastage) by the consumers. Reducing avoidable FW is important since it represents food that might have been consumed, hence offering direct chances to improve sustainability and save resources. (Di et al., 2019; Lebersorger and Schneider, 2011; Shaw, 2021; Soma et al., 2021). Targeting avoidable FW not only reduces the environmental effects but also contributes to food security by keeping edible food out of landfills (Lebersorger & Schneider, 2011; Shaw, 2021). Avoidable FW has a great chance of helping those in need and addressing issues with food security brought on by population growth (Alexander et al., 2017; Shaw et al., 2018). Since many beneficial outcomes result from concentrating on avoidable FW, there are many studies are putting particular attention to lowering FW in this area (Di et al., 2019; Lebersorger and Schneider, 2011; Shaw, 2021; Soma et al., 2021; Lebersorger & Schneider, 2011; Shaw, 2021).

The study showed that respondents had a high level of intuitive understanding regarding the level of avoidable FW they generate. This observation was seen in the distribution pattern of perceived HFW levels (Fig. 2), where consumers who believe they generate less FW align with the actual avoidable HFW data and vice versa. This implies that a large number of consumers have a fundamental understanding of the FW they produce, especially when it comes to waste that could have been avoided. Some possible reasons Hungarian consumers demonstrate a strong intuitive understanding of their FW levels may be their health and environmental concern awareness (Pércsi et al., 2023). Several former studies reported that consumers with a strong health awareness attempt to practice intuitive eating or try not to overeat (Barker et al., 2023; Ellison and Prescott, 2021); as a result, they are indirectly conscious of reducing their FW. Pércsi et al. (2023) also reported a possible link between individuals' environmental awareness and their FW behaviour.

The study shows that Hungarian consumers seem to have an instinctive understanding of the FW they can avoid. This understanding may stem from their increasing concerns regarding health issues and environmental protection. Therefore, FW may be reduced due to the existence of self-regulating mechanisms, such as self-mindful consumption or sustainable mindful consumption, which increase awareness of a person's health and environmental issues.

Additionally, this result might be an important contribution to the current EU policy-making process to establish more explicit legislation with regard to the difference between avoidable and unavoidable FW. This paper also aims to bolster the efficacy of national

Table 2
Definitions of dependent variables (n = 282).

Variable	Description
Respondents' opinions about how much FW is generated in the household	
Respondents' perceived FW level	1 if a respondent thinks that their FW production is below the average; 2 if the respondent produces FW somewhat below the average; 3 if the respondent produces the average of FW; 4 if the respondent produces FW somewhat above the average; 5 if the respondent produces FW far above the average
Respondents' perception of the capability to reduce FW	
Perceived capability	1 if the respondent thinks they can reduce FW significantly; 2 if the respondent thinks they can reduce FW but not significantly; and 3 if the respondent thinks they cannot reduce FW

Source: Own data collection

Table 3
Characteristics of the FW (kg/person/year).

Food waste categories	Descriptions	Amount
Total FW	Total FW in a household (average)	65.50
Avoidable FW	Avoidable FW in a household (average)	25.19
Unavoidable FW	Unavoidable FW in a household (average)	35.72
Potentially avoidable FW	Potentially avoidable FW in a household (average)	4.60

Source: Own data collection

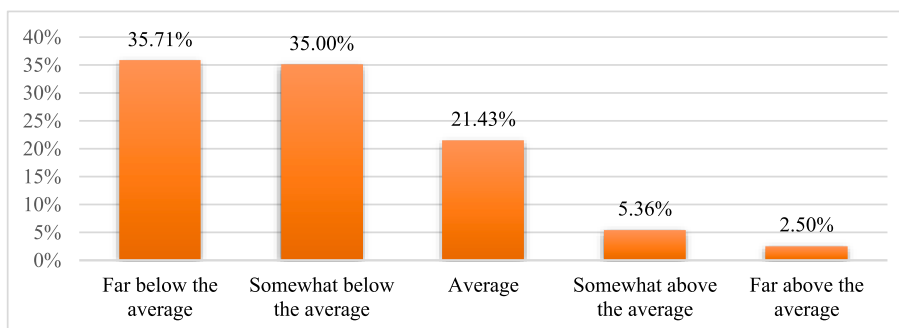
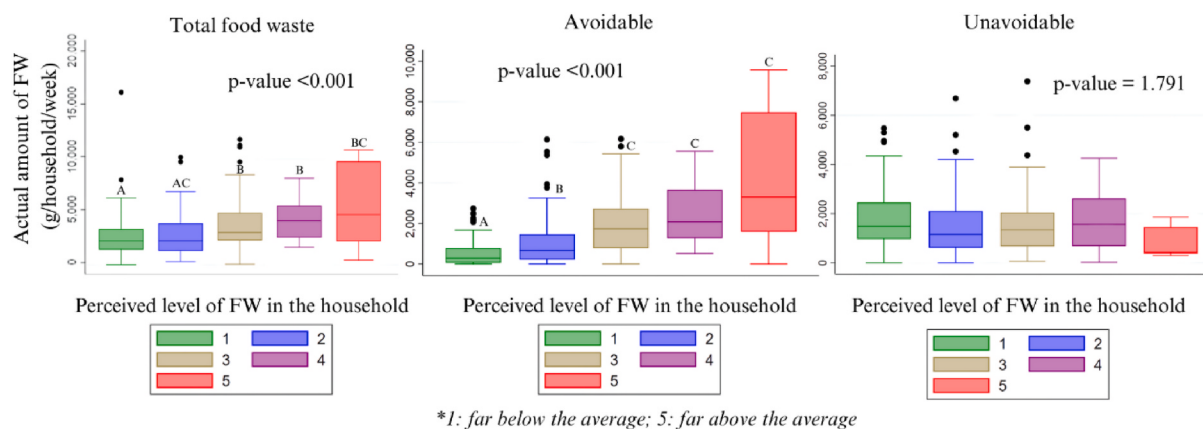


Fig. 1. Households' perception of their own total FW level.



Note: P-values show the results of the Kruskal-Wallis nonparametric test. A post hoc test was applied to investigate differences between groups. The same letters (e.g., A-A) present in different groups indicate that there is no significant difference between them (95% CI); g stands for gram.

Fig. 2. The relation between the actual amount of HFW and its perceived level by the respondents.

Note: P-values show the results of the Kruskal-Wallis nonparametric test. A post hoc test was applied to investigate differences between groups. The same letters (e.g., A-A) present in different groups indicate that there is no significant difference between them (95% CI); g stands for gram.

FW prevention programs (Huber-Humer et al., 2017). This task is critical because, although categorizing FW as avoidable and unavoidable is quite common, it is still used inconsistently in many cases (Lebersorger and Schneider, 2011; Scherhauser et al., 2018). In addition, various existing debates in the EU Platform on Food Losses and Food Waste focus on the differences between avoidable and unavoidable FW (European Commission, 2017, 2023b). With concise and well-defined differentiation, the stakeholders, policymakers and government can focus on crafting and developing more tailored strategies for addressing the fundamental sources of FW issues while managing the aspects that are inevitable. Therefore, with the help of these approaches, stakeholders could be able to make more robust and effective decisions.

4.3. The level of underestimation of HFW

The results in Fig. 3 suggest that the respondents of the survey possess a pragmatic understanding of the level of avoidable HFW they generate. However, when asked for quantified estimations of how many kg of FW they create per capita annually in their own households, 84.04 % of the respondents demonstrated a tendency to underestimate it. It was shown that only 2.13 % (with an allowed deviation level of ± 5 %) of the respondents had a realistic perception of their FW levels, while 13.83 % exhibited an overestimation.

Examining the disparity between estimated HFW and the corresponding real amounts reveals that the estimated total FW average amounts to 33.7 kg per capita per year, while the actual total FW stands at 65.5 kg per capita per year (Fig. 4). According to this study, Hungarian consumers are inherently prone to underestimate the total FW generated by them, with an average underestimation of 48.5 %. In addition to this, [Everitt et al. \(2022\)](#) also noted an underreported generation of FW as a result of many households being solely questioned and surveyed via a questionnaire. However, in this study, authors combined questionnaires with direct FW measurement using the FUSIONS methodology ([Kasza et al., 2020](#); [Szabó-Bódi et al., 2018](#)), providing a more accurate estimate of understanding the level of household FW generation.

These conclusions from the results are corroborated by earlier research that demonstrates consumers' observed propensity to underestimate the quantity of FW they produce ([Ahmed et al., 2021](#); [Jörissen et al., 2015](#); [Quested et al., 2013](#); [vanHerpen et al., 2019](#)). In addition, [Jörissen et al. \(2015\)](#) also reported that consumers with high environmental awareness tend to generate less FW when asked; however, they actually found that they underestimated their actual FW generation. This phenomenon might hinder the effectiveness of national FW prevention campaigns. Moreover, [van Dooren et al. \(2019\)](#) highlighted that a consumer survey that only asked consumers about the frequency of discarding food also revealed a significant underestimation. The distinctive insight this study provides by involving a direct comparison between consumer perceptions and the actual quantity of total and avoidable FW they generate may effectively contribute to awareness-raising campaigns. The study has the potential to enhance the development of programs aimed at addressing FW as well as have a unique contribution that would assist stakeholders in understanding consumer behaviour more accurately.

4.4. Households' capabilities in reducing HFW

Given that consumers are accountable for a substantial proportion of FW, its mitigation at the household level emerges as a pivotal measure required to enhance environmental sustainability and ensure food security ([Stancu et al., 2016](#); [vonKameke and Fischer, 2018](#)). Consumers are accountable for 61 % of FW globally ([UNEP, 2024](#)). In recent years, many educational and awareness-raising initiatives have been launched with the objective of changing consumer behaviour to mitigate FW ([Simões et al., 2022](#)). According to behavioural scientific findings, the perceived behavioural control of consumers is a critical element in shaping behavioural patterns ([Ajzen, 1991](#); [Conner and Armitage, 1998](#)); therefore, this study also endeavoured to explore this factor.

Based on the findings shown in Fig. 5, it has been found that the majority of the respondents (77 %) reported the capability to further mitigate the FW level they currently generate. Among this group, 17.02 % expressed confidence about a significant reduction capacity, while 59.93 % indicated that they would be able to decrease FW moderately. Only less than $\frac{1}{4}$ of the respondents perceived no further opportunity to decrease their present HFW level. In summary, the findings of this study indicate that Hungarian households possess substantial potential to mitigate their current level of FW.

The high perceived capabilities of the respondents in reducing FW may be attributed to the positive trends in FW reduction in Hungary ([Kasza et al., 2020](#); [Szabó-Bódi et al., 2018](#)). This encouraging trend aligns with the successful Hungarian national FW prevention program called Wasteless, which has carried out a lot of FW education and awareness-raising activities since 2016 ([WASTELESS, 2022](#)). The Wasteless program has been instrumental in its goals of consumer education towards FW management and increasing FW awareness. The program has collaborated with many campaigns, workshops, and information dissemination activities

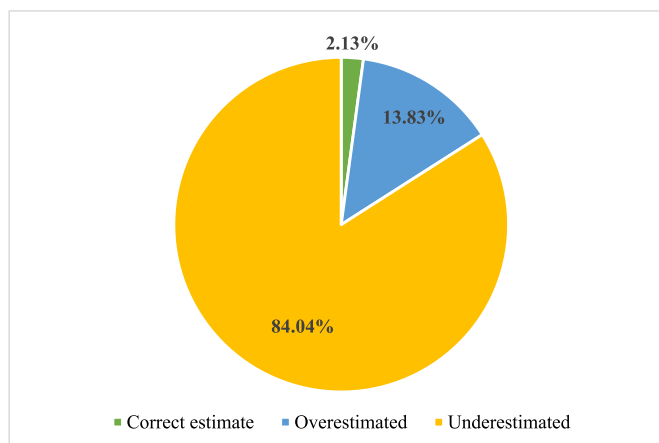


Fig. 3. The accuracy level of respondents' estimates regarding their own total FW generation.

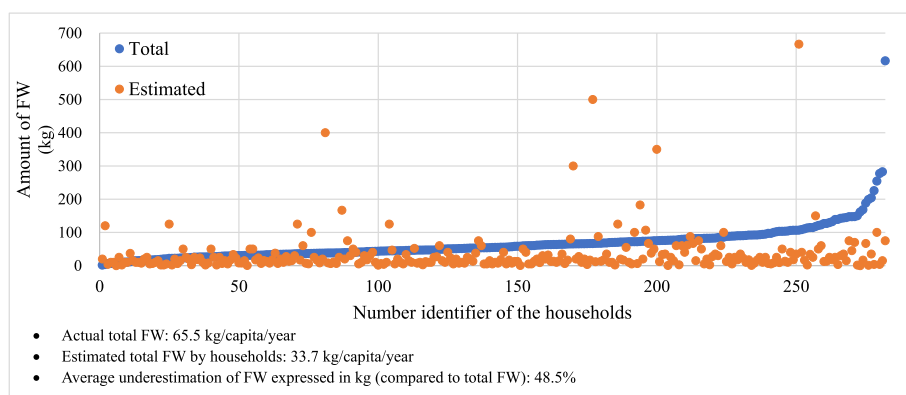
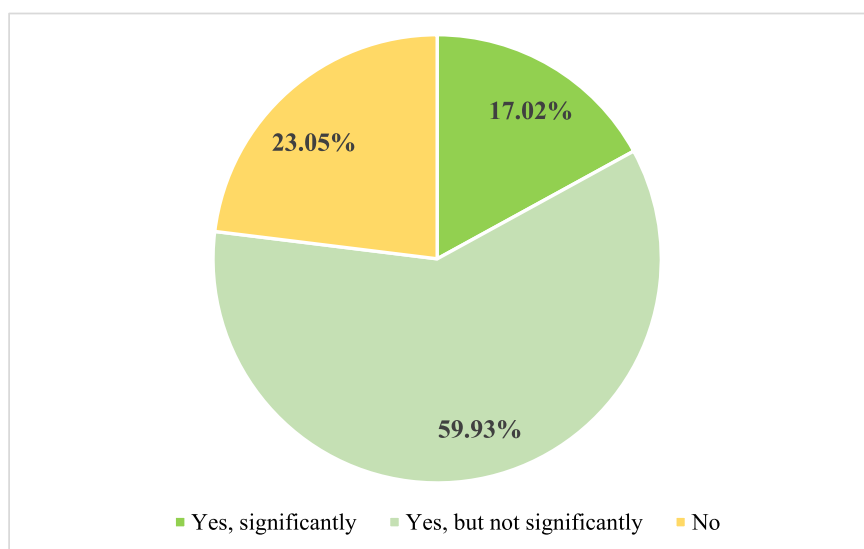


Fig. 4. Comparison of actual and estimated own total HFW values in Hungary.



Note: Share of answers to the question “Would your household be capable of reducing food waste?”

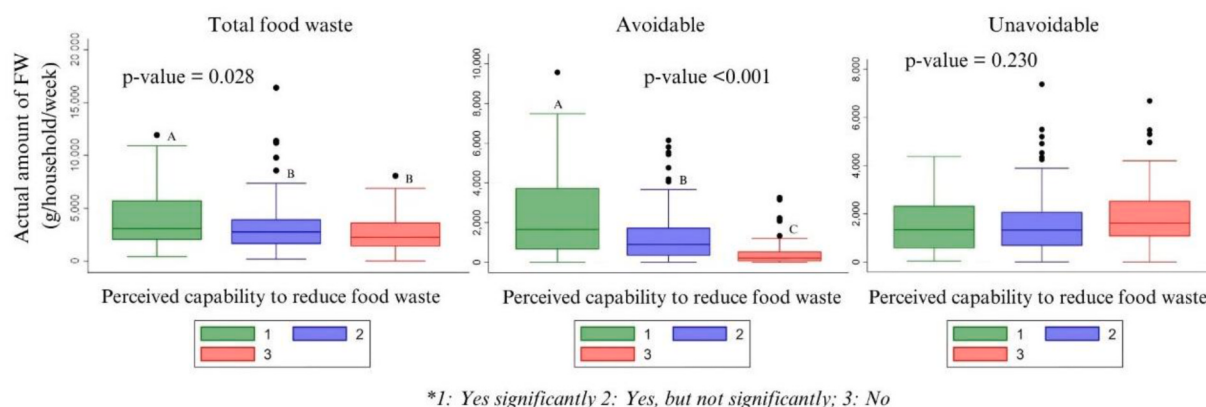
Fig. 5. Respondents perceived their capabilities to reduce FW.

Note: Share of answers to the question “Would your household be capable of reducing food waste?”

to inform Hungarian consumers of the environmental, economic, and social impacts of FW and promote responsible food management practices (WASTELESS, 2022). As a result of these activities, it is assumed that Hungarian consumers have become more aware of FW issues and have started adopting more sustainable food management practices. Prior studies also mentioned that strong knowledge and good food management practices are significant factors that can assist in reducing FW (Ananda et al., 2021; Begho and Fadare, 2023; Chheang et al., 2023; Janssen et al., 2017). This study highlights the need to educate consumers not only on how much food is wasted but also on practical ways to reduce waste in their daily lives.

Socio-demographic analysis did not show relevant associations of perceived ability to reduce FW with household characteristics (e. g., household size, type of residence, type of home, i.e., house with garden and other). This indicates that other factors like personal attitudes, social norms, motivations, or awareness of the real quantity of FW that is actually generated towards the household may be more prominent.

In the context of consumers' perceived capability to reduce FW, this study also identified significant differences related to the different categories (total, avoidable, and unavoidable FW) (Fig. 6). According to the results, respondents who believed their households were capable of considerably decreasing FW produced significantly more avoidable FW. Conversely, respondents who indicated their households' inability to reduce FW generated significantly less in the avoidable category. A similar trend has not been observed in the case of the unavoidable category. This finding demonstrates a similar pattern to the result shown in Fig. 2, whereby Hungarian households exhibit substantially higher awareness of their avoidable FW generation compared to other FW categories. The same narrative might be established here, that is, consumers clearly distinguish between avoidable and unavoidable FW. While the production of avoidable FW is perceived as a real problem, FW that cannot be avoided is not necessarily perceived as such, and its



Note: P-values show the results of the Kruskal-Wallis nonparametric test. A post hoc test was applied to investigate differences between groups. The same letters (e.g., A-A) present in different groups indicate that there is no significant difference between them (95% CI); g stands for gram.

Fig. 6. The relationship between Hungarian households' capability to reduce FW and FW categories.

Note: P-values show the results of the Kruskal-Wallis nonparametric test. A post hoc test was applied to investigate differences between groups. The same letters (e.g., A-A) present in different groups indicate that there is no significant difference between them (95 % CI); g stands for gram.

reduction is not necessarily seen as feasible either. Former studies also highlight that avoidable FW is the category that urgently needs to be addressed in order to reduce the amount of FW (Schott and Andersson, 2015; Yamada and Asari, 2017).

The findings of this study not only highlight the need to distinguish between avoidable and unavoidable FW but also underscore the need to prioritize initiatives aimed at mitigating FW within the avoidable category. This has also been raised by earlier studies promoting interventions aimed at reducing avoidable FW for the achievement of SDG 12.3 (Shaw et al., 2018; Young et al., 2017; Leverenz et al., 2019). Focusing on the avoidable category makes it possible for policies and actions to be more strategically concentrated on all practices and sectors that contribute to avoidable FW.

5. Conclusions

By integrating investigations on the relationship between consumers' perceived level of FW and their actual quantity of HFW, this study confirms that Hungarian households generally have a high level of awareness regarding their avoidable FW generation. However, upon further inquiry into the quantity of HFW generated per capita per annum, respondents demonstrated a tendency to underestimate their HFW production, which was relevant for 84 % of the sample. Conversely, 14 % of the respondents exhibited a propensity to overestimate, while a mere 2 % perceived their HFW generation realistically. In comparison to the actual amount of total HFW in Hungary (65.5 kg per capita per year), households exhibit an underestimation rate of approximately 48.5 % (the average of the estimations was 33.7 kg per capita per year).

The research highlights the capability of Hungarian households to decrease HFW further (77 %). The perception of reduction capability is correlated with the amount of avoidable FW generation in households.

The results of this study demonstrate the significant importance of the distinction between avoidable and unavoidable FW in policy-making, highlighting that unavoidable FW is not perceived in fact as 'food waste' by most consumers. Hence, only the reduction of avoidable FW seems feasible in communication campaigns. Promoting the reduction of unavoidable FW would be highly controversial (e.g., less home cooking, eating out). At the same time, campaigns and intervention actions should also address unavoidable FW. In that case, proper management techniques should be promoted in line with the FW Hierarchy, exploring the possibilities provided by their residential area (e.g., animal feeding, home composting, community composting, separate biowaste collection).

As observed, FW categorization, such as edible/inedible FW and avoidable/unavoidable FW is often controversial, and the obligatory FW reports of EU Member States are just in the learning phase, revealing many methodological challenges to be solved in the next years. These might suggest that EU policy should establish a universal commitment and a well-functioning data collection in the Member States first, and deal with the details (such as the distinction of avoidable and unavoidable FW) later. By the end of 2027, the Commission will review the targets and possibly modify them in the light of new evidence (European Commission, 2023c, 2023d). The results of this study strongly support that the distinction between the avoidable and unavoidable HFW should be made by then, and the focus should be shifted from total FW to avoidable FW. Until then, FW experts, awareness-raising practitioners, and policy-makers at the national level are advised to implement these findings in their awareness campaigns, educational activities, and national policies.

The study provides valuable insights and directions for future studies by highlighting the need to differentiate between avoidable

and unavoidable FW in regard to its consumers' perception and policy framework. By exposing significant underestimation of FW generation among households, it highlights a key area for further research and studies to explore consumer awareness, attitude, and behaviour patterns, especially in the avoidable category. Besides, this study also recommends that future research investigate the impact of integrated, targeted interventions and communication strategies focused on consumers' behavioral change related to the generation of avoidable FW. It also suggests assessing the potential impact of local and national FW management policies, such as biowaste collection or community composting, along with individual household-level practices, such as feeding pets and livestock. This study can also serve as a basis for the development of standardized FW measurement and classification in the research, government, or policymaker literature, which is now being discussed in EU policy contexts.

Despite the fact that this research followed the EU-recommended data collection methodology, it has some limitations that need to be considered. Since the survey is based on convenience sampling, with recruitment relying on voluntary applications, consumers engaged in sustainability topics were more likely to participate in the research. In addition, the sample is not representative of the Hungarian population in terms of demographic characteristics. Another possible source of error in the applied methodology is the social desirability bias during the measurement period. This bias implies that consumers, being aware of the measurement, may act differently, altering their food consumption and wasting habits, thereby affecting the generated amount of FW.

CRediT authorship contribution statement

Atila Kunszabó: Visualization, Formal analysis, Writing – review & editing, Methodology, Data curation, Validation, Conceptualization, Writing – original draft. **Gyula Kasza:** Methodology, Investigation, Writing – review & editing, Supervision, Project administration, Conceptualization, Writing – original draft, Visualization, Validation, Resources. **Dávid Szakos:** Validation, Conceptualization, Writing – review & editing, Supervision, Writing – original draft, Methodology. **Judit Oláh:** Supervision, Validation, Methodology, Writing – review & editing. **Zoltán Lakner:** Methodology, Validation, Supervision. **József Popp:** Validation, Writing – review & editing, Methodology. **Widya Satya Nugraha:** Software, Writing – review & editing, Visualization, Data curation, Writing – original draft, Formal analysis. **Annamária Dorkó:** Writing – review & editing, Methodology, Investigation. **Miklós Süth:** Writing – review & editing, Validation, Methodology, Supervision.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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