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Household Attitudes and Behavior towards the Food Waste Generation before and during the COVID-19 Pandemic in Romania

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Abstract: Food waste represents an important aspect with social, economic, and environmental implications. As previous studies underlined, the COVID-19 pandemic led to changes in the food consumption patterns among consumers. The aim of the study was to investigate the main changes in household food waste management during the COVID-19 pandemic in Romania compared with the period before the COVID-19 pandemic. Factors affecting food waste were also analyzed. Data were collected among Romanian households using an online administrated questionnaire. The 784 usable questionnaires were analyzed using descriptive statistics and Cluster analysis. Consumers' food shopping habits have become more sustainable during the pandemic, with a positive impact on waste management. The amount of the food losses decreased, people found ways to valorize the food scraps. The Cluster analysis of 25 food waste behavior factors lead to a 3 clusters solution: "wasters" (n = 264), "careless consumers" (n = 227), "careful consumers" (n = 359). While the "wasters" group was represented by consumers who chose to plan the shopping and the menu for the next period, were represented mainly by males with a lower level of education, the "careless consumers" did not choose to plan before going shopping, they discharge lower quantities of food compared with the first group. The "careful consumers" proved to be the most organized one, being preoccupied about the menu planning and reuse of leftovers. People became more conscious about their shopping habits; however, not all groups greatly improved their habits. The results indicate that more actions are needed to increase the awareness at the household level regarding food waste management and sustainable consumption during changing times.

Keywords: food management behavior; food consumption; food waste; consumer behavior

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1. Introduction

The sustainability of food supply is closely linked to food consumption [1]. A sustainable future for the community is one of the goals established by the European Union's 2030 Agenda, sustainable consumption being identified as a pathway for sustainable development [2–6]. Purchasing products sustainably is important but insufficient and should not be the only way to address sustainable food consumption [7,8]. Reducing consumption in food categories that cause a high environmental burden is an important way to reduce environmental impact [8–10].

The unsustainability of food consumption is closely linked to food waste [11]. Food waste (FW), as defined by the Food and Agriculture Organisation (FAO), "refers to food appropriate for human consumption being discarded, whether or not after it is kept beyond its expiry date or left to spoil" [12]. It is the result of actions taken at all levels of the food chain, starting from the production plants and ending with the final consumer [13,14]. Food waste is found to be generated by market decisions that lead to oversupply and consumers' behavior [12]. The main action to be implemented in a successful food waste (FW) management strategy is to avoid producing such waste in the first place. Although the elimination of food waste is impossible because some of it is unavoidable, prevention methods can be an effective alternative for substantially reducing food waste through policies, programs, campaigns, and changes in human behavior [15]. The amount inevitably generated by FW must therefore be highly separated from the source. Prevention can be achieved by trying to reduce losses and, therefore, by reducing the demand for food production or by redirecting food losses further by providing safe and edible FW to other end consumers. Several papers have analyzed the behavior of companies and people in developed countries at different levels (household, restaurant, retail) to assess the governance factors that influence food waste [16–23].

In the food supply chain, the end-consumer has a driving role. Its feedback may influence the decisions of the other actors. Therefore, campaigns directed at consumers are crucial [24]. In the last decade, several actions to inform consumers about the importance of reducing food waste have been supported by food companies and governmental institutions. The urge for policies, programs, and campaigns to promote sustainable consumption and minimize food waste stems from the need to find long-term solutions to the vast yearly volume of food waste which the United Nations (UN) estimated to be around 1.3 billion tons in 2015 [25]. Food waste reduction is crucial for food security because the global population is expected to expand dramatically by 2050, reaching 9.6 billion people [25]. In the UK, Welch et al. recognize the efforts of retailers on encouraging consumers to buy less [26]. The British campaign "Love Food Hate Waste" is by far the most successful food waste awareness campaign conducted in Europe so far [27]. This campaign is an example of a complex strategy that includes consumer education as well as a technical program on food formulation, packaging, and marketing [28]. Being established in 2015 to combat food waste, it presented in 2016 "A Roadmap for Reducing US Food Waste by 20%", involving 27 unique solutions (12 avoidance, 7 redistribution, and 8 recycling/recovery) along with the projected results for each individually proposed measure [29]. Another example of a waste reduction initiative is the Zero Hunger/Zero Waste project, which aims to distribute food produced and uneaten to vulnerable people in the United States [30]. The project is widely encouraged by a private company and involves several partner companies across the country. However, the main goal of this project is to reduce the value wasted in institutions to zero, which means efficient and effective production [30]. Other current examples are the "Stop Food Waste Program" in Ireland, "Lebensmittel sind kostbar!" in Austria or "Think. Eat. Save Reduce your Foodprint" in Europe, "Food Battle" in the Netherlands, and "Stop wasting food" in Denmark [27].

In Romania, the measures regarding the prevention of food waste are regulated by the Ministry of Agriculture and Rural Development (MADR) by law 217/2016 and GD 51/2019. Moreover, MADR concluded with the Ministry of National Education and the INFOCONS Association a collaboration protocol for information and education campaigns targeting consumers, mainly from the pre-university. Another initiative whose results aim to be the basis for public policies to prevent and to reduce food waste can be found in the Sectoral Plan for research and development in agriculture and rural development, starting with 2015 [31]. Other examples of initiatives to reduce food waste are "Attention, delicious" or "Stop waste" [32,33]. Romania wastes 10% of purchased food, representing 129 kg/year/capita, considering that 4.5 million people face difficulties to assure the daily food basket [34]. The National Institute of Public Health mentions that people who have high incomes waste the most, and the bigger the family, the more food is thrown away [35].

The greatest food waste occurs in urban areas, with more than 95% of food being wasted. In contrast, rural communities use traditional methods to recover household food waste [36].

Scholars acknowledge that the lack of awareness about the negative impacts of food waste is present at all stages of the food supply chain. It is clearly one of the main causes for the presence of a high amount of food waste at the household level. Finn claims that nowadays, the act of throwing food is a normal habit for many consumers being indifferent or unaware of the quantity of the food waste and its impact, and therefore an urgent change is needed in this respect to make people more responsible [24].

Food waste reduction programs and campaigns are dependable on up-to-date information about consumers' behaviors related to food waste. Thus, a closer look is needed in order to provide a complete perspective on the current relationship between consumers and behaviors towards food waste produced at the household level.

Today, people are experiencing changes in their life habits due to the unexpected and rapid spread of COVID-19 pandemic (state of emergency, quarantine, self-isolation, etc.). From this perspective, this article looks into food waste as one of the major concerns that must be addressed in order to ensure a long-term food supply. The aim of the paper is to identify if there are any significant changes in terms of food waste behavior before and during COVID-19 pandemic in Romania. The following objectives were set up: to identify the impact of COVID-19 pandemic on shopping habits; to analyze the main reasons for food discarding; to identify the main categories and frequency of discarding food products; to analyze the management routines of leftovers. Furthermore, it was considered appropriate to cluster the respondents based on their waste management habits and to identify the characteristics of each group. The empirical study conducted in Romania intends to reveal the internal and external factors that support or undermine the decision to waste food in-house/at the household level. Based on all the aspects mentioned above, the following research questions were addressed: Have consumers experienced any change in shopping habits? What are the main reasons and habits related to discarding food? Can consumers be segmented based on their household food waste behavior? At the same time, the following research hypotheses were stated:

H1: *There are no significant changes in consumers' behavior related to household food waste during the COVID-19 pandemic compared to the pre-pandemic period.*

H2: *Consumers' behavior is the same, regardless of the shopping habits, waste management, and socio-demographic characteristics.*

2. Literature Review

2.1. Impact of the Household Food Waste

It is well known that industrialized countries have a considerable quantity of food waste at the consumer level [37], with the consumer being in charge of both food purchase and disposal decisions [14]. Thus, a classification of food waste by income level indicated that for the high-income countries, the average food waste is 79 kg/capita/year, for upper-middle-class countries, it is 76 kg/capita/year, while for lower-income countries, the amount of food waste is significantly higher, of 91 kg/capita/year [37]. At a European level, a technical study concluded that the total amount of food produced in 2011 was 865 kg/person/year, while the food waste/person was 173 kg, meaning a high proportion (20%) of food is wasted [38]. Among the major sectors that generate the most food waste, the households represent the main contributor (92 kg per person), followed by the processing sector (33 kg per person), food service (21 kg per person), primary production (18 kg per person) and the wholesale and retail sector with the lowest quantity of waste, only 9 kg per person [38].

The role of consumers in food waste is recognized by many researchers [13,14,19]. Several empirical studies highlight the rather high quantities of food waste at the household level [14,26,37,39,40]. A cross-national study conducted by Rohm et al. approached the problem of suboptimal food as an important source of food waste and concluded that a large

quantity of food waste could be avoided by analyzing the three major factors that often lead to food waste: product-related factors, personal related factors [14]. The results of the study offered interesting and useful information about how the consumers position themselves towards the food they are eating. A large amount of food waste appears because some food products do not meet the consumer's expectations in terms of appearance, but also because of one's education, amount of information about the product, the intrinsic motivation for becoming a sustainable consumer, or even the human emotions [14]. On the one hand, the study concluded that the consumers must change their perception of food waste, and, on the other hand, the legal institutions must also intervene to reduce the phenomenon by different policies and regulations. There are studies that estimated the amount of food waste generated by one consumer per year or daily. In Croatia, the daily average of food waste per person within one household is 0.21 kg [41]. The Dutch consumers wasted 30.4 kg per year, while the Finnish consumers wasted 23 kg per year [42–44]. In Norway, the amount of food waste was 46.5 kg per capita, and in Hungary, it is 68.04 kg per capita [45,46]. When it comes to food waste in the UK, Quested et al. estimated in 2011 the costs of food waste to £12 billion, with 8.3 million tons of waste generated by households alone, contributing a further 3% of the total national greenhouse gas emissions [47]. In comparison, Jeswani et al. conducted research on the extent of food waste in the UK and its impact on the environment, estimating in 2021, 13.1 million tones are generated every year across the supply chain [48]. Additionally, studies have also assessed the issue of food waste and food loss in developing countries, in particular those from the Near Est and North Africa, with estimates of 34% of the total food supplies for consumption being lost [49,50].

2.2. Motivations for Food Waste

Food waste factors/drivers have been thoroughly researched in the literature in order to present a full picture of food waste. In this context, some studies have emphasized the significance of the variables that determine the consumer habits, as well as the intervention sites [51–53], while other studies focused on identifying and grouping the food waste drivers at a European level [54]. The COVID-19 pandemic induced various changes in food-related behaviors worldwide, including food waste. Therefore, there is a need for a better understanding of household food waste. Among the elements investigated in the present study are the food shopping habits, motives for discharging food, categories of discharged food, use of leftovers in households, and cooking habits.

2.2.1. Shopping Habits

Irresponsible shopping behavior and the lack of shopping lists create the optimal conditions for the food waste phenomenon within households by over-provisioning and high sensitivity to marketing offers and campaigns [13,19,55–61]. Thus, good household management is essential [62,63]. Planning routines represent an important factor of waste prevention and reduction throughout the use of shopping lists [64–66], but also other actions like educating the young consumers to understand some negative aspects of advertisements and reduce the demand for some products which might end up to trash [67]. Recent studies showed that during the pandemic, there was a general tendency of the population to buy food products from supermarkets, while only a smaller percentage chose small shops, local markets, farms [64,66,68]. Additionally, the frequency and the quantity of food shopping were influenced by the pandemic, the majority of individuals buying less often than before the epidemic and in higher quantities [64,66], panic purchasing and food stockpiling were common phenomena [69–72].

Shopping habits are considered an important element that influences the amount of food waste [73], throughout sticking to the shopping list, avoiding impulsive purchases, checking the labels [74–77], but a direct effect is not always identified [78]. Planning routines like checking the inventory of food before going shopping planning meals in advance remain an important factor of prevention for food waste phenomenon, especially through shopping lists [56,76], but also by educating the young consumers to understand

some negative aspects of advertisements and to reduce the demand for some products which might end up as trash [67]. Preparing shopping lists before going to the supermarket is recognized by many scholars as an important act of waste prevention [79]. Interesting findings showed that the place of purchase is related to the food waste: the amount of food thrown away is highest when people purchase exclusively from supermarkets and decreases with the size of the shop, being almost unexistent when people produce their own food [80].

2.2.2. Motives for Discharging Food

There are opinions according to which the responsible for the food waste phenomenon is not only the consumer but also the whole system of producers-consumers [26]. A part of the food waste is avoidable, and it is considered that it generally occurs at the end of the production chain (meal preparation and distribution); therefore, the identification of the processes that generate it and also reduce its impact are of utmost importance [81]. Spoilage is one of the reasons for producing food waste, and by spoilage, it can be understood as growing mold, passing the "best before date", cooking in excess, and leftovers [20]. Packaging could represent another reason for wasting food, being either too big or too difficult to empty [76,82] or passing the best before date [20]. Other scholars noticed that a misunderstanding of the food labels often leads to food waste [83,84]. Porpino et al. conducted a study among lower-income families from Brazil and identified some major types of food waste causes: excessive purchasing, over-preparation, inappropriate conservation, expiration date [85]. These results were comparable to other research from Italy, Macedonia, and Tunisia [64,66,68]. Pearson et al. identified nine behavioral drivers of food waste: lack of awareness or indifference related to the food waste, affordability of food wasting, high-quality standards (nutritional and health aspects), insufficient purchase planning, buying food in excess, cooking food in excess, lack of cooking skills, high sensitivity to food safety, change of meal plans [13].

2.2.3. Categories of Discharged Food

By analyzing which are the main categories of discharged food during the pandemic, it can be noticed that cereals, pastry, vegetables, fruits, milk, and dairy products are the most commonly wasted [64,86]. These findings are in line with the results of studies carried out before the COVID-19 outbreak [18,46,87,88]. According to a study conducted by Amicarelli and Bux, the most discharged food categories were in the following order: fruits, vegetables, fish and fish products, meat and meat products, milk and dairy products, pasta and rice, bread and bakery products and prepared meals [89]. On the contrary, fish and seafood, as well as meat, were the least discharged food groups, as revealed by Bogevska et al. [64]. As an overall observation among studies, vegetables were among the most prevalent of the wasted food categories [66,89,90]. In Macedonia, cereals, and bakery, fruit, vegetables, milk, and dairy are frequently thrown away, while meat products, fish, and seafood are the categories least wasted, due to their high price, and therefore receive special attention from the consumers, when stored and cooked [64]. In Greece, a direct connection has been observed between the individual consumption pattern and the categories of discharged food: individuals relying on fruits and vegetables recorded less food waste, while the households with a high-protein and starch consumption led to increased waste for all types of food categories [78].

2.2.4. Use of Leftovers

An important factor of food waste prevention is the individual household skills that are often associated with the reuse of leftovers [62] or cooking in adequate quantities [57,58,91]. Consuming the leftovers is considered to be a positive behavior [19,20,63,79,92] while existing alternatives for their reuse could reduce the food waste phenomenon [93]. During the pandemic, such alternatives consisted in feeding the animals with the leftovers, cooking new recipes with the leftovers, eating them the next day, freezing them, sharing the cooked

meals, donating, but there were also cases of simply discharging the leftovers at a high percentage [64,94–97]. The researches cited above demonstrate that during confinement, people were concerned about food waste. Apart from the many ways leftovers can be used in a household in order to limit food loss, research in this area has suggested certain industrial methods, such as turning the waste into raw materials that could further be used in various biochemical processes, in particular the inedible fraction of food waste [98]. Additionally, significant progress in the field of biotechnology has led to alternative ways of nutrients production. Thus, cyanobacteria cultures using food waste as a substrate produce protein powder, representing a possible alternative to the traditional protein sources causing more pollution, such as beef and pork [99].

2.2.5. Cooking Habits

Cooking habits refer to the preferences regarding the in-house food preparation of the population. Changes in eating and cooking patterns were identified throughout various research studies, revealing that the frequency of cooking during the quarantine increased, which was determined by several factors, such as the impossibility to go to restaurants, the remote work, with more time available for meal planning and cooking, the pandemic having a positive effect from this perspective [100–105]. Subsequently, the consumption of vegetables, fish, and homemade pastries was higher compared to the consumption of unhealthy products [100]. In contrast, some studies reported lower consumption of vegetables and fruits [106,107]. Home cooking has been generally associated with a healthy diet [106,108–110].

Cooking routines are also considered responsible for the food waste phenomenon, more precisely, the lack of cooking skills [78,86,111] which was mentioned as an important barrier in food waste reduction [20,62,86]. Yetkin Özbük et al. referred to cooking skills as the ability of a household to keep and reuse leftovers, proper storage, and a rationale for cooking by minimizing losses [112]. Poor cooking skills have other implications, like the incapability to buy the necessary ingredients, causing over-shopping and leading to food waste [113]. Yetkin Özbük et al. clustered the Turkish respondents into three segments by taking into consideration the shopping habits and the cooking skills, concluding that the pandemic improved the Turkish cooking skills by staying more at home, thus contributing to the food waste reduction [112].

2.2.6. Socio-Demographic Determinants of Food Waste Behavior

As emphasized by Verain et al., the heterogeneity of consumers plays an important role in understanding the consumption patterns [1]. Thus, the identification of consumer segments is crucial for the actors of the food supply chains. These are key players in the process of promoting and sustaining the food waste reduction actions towards sustainable consumption in the long term. Thus, the influence of socio-demographic characteristics on consumer behavior related to food waste was deeply analyzed. Age has an important influence on food waste [62,80,114–118]. However, there are studies that emphasize the lack of correlation between the two variables [67,76]. A Romanian study found out that, at each stage of age, women are more concerned about the implications of food waste on social equity than men, in accordance with previous research [114,119,120]. When it comes to concerns about the environmental impacts of food acquisition and preparation, women tend to contribute more to food waste than men [114]. Stancu et al. observed that the Danish consumers' food waste behavior was strongly correlated to age, older consumers being associated with lower amounts of food waste [62]. These findings are in line with other researches [19,45,80,115–117,121]. This situation could be explained by the experience of older people with World War II and the high prices of food [91], but also by good household management with planning meals in advance and better knowledge about food waste [19,122,123]. In New Zealand, it was found that food waste increases particularly in households with more younger people, indicating a lower interest in the environment at early ages [118], results backed by other studies [19,124]. Income also determines, in some

cases, the amount of food waste within the households, a positive correlation between income and the amount of food waste generated being observed [45,76,125,126]. The phenomenon is related to the fact that mid to low-income consumers purchase a higher amount of low-quality food and generate more food waste [127]. The education level is an important factor in Poland, the university-degree level being related to higher income and less time for the household management with implications for the products that passed the expiry date or are kept in inappropriate storage conditions [115]. Similar results were obtained by Secondi et al. [128]. There are also scholars that did not find any correlation between the amount of food waste and the level of education [76], while others established an inverse correlation [129,130]. A cluster analysis of the Romanian consumers regarding the food waste behavior concluded that individuals from the cluster entitled the "ignorants" have a high level of education [131]. The household size is another possible predictor of food waste behavior, a positive correlation being observed by scholars [125]; generally, the fewer members within a household, the fewer waste is generated [76,80]. Households with more children produced more food waste than those without children [41].

3. Materials and Methods

The current research assumed a two steps analysis. During the first step of the research, an analysis of the existing literature was conducted in order to understand the behavior trends during the crisis periods and to identify possible factors that shape consumers' behavior. Then, based on the previous step, the research instrument was developed. Based on the developed questionnaire, the data were collected and further analyzed (Figure 1).

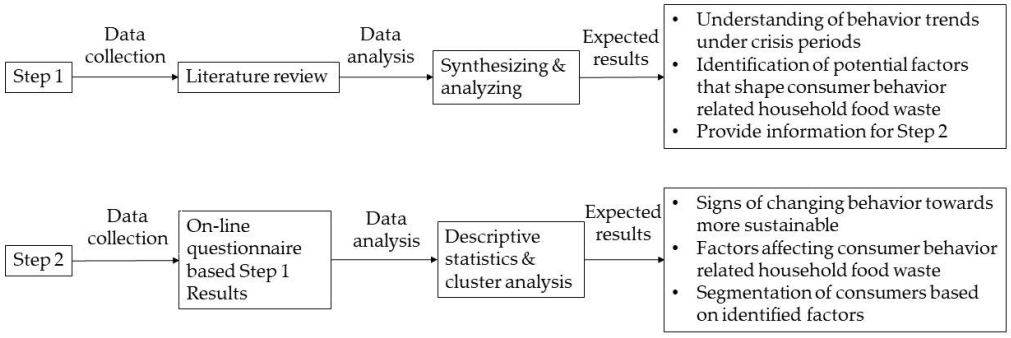

Figure 1. Research flow chart design.

3.1. Measurement Instrument

For the purpose of the paper, a questionnaire was developed. The collected data can be divided into two main categories: (i) food waste consumer behavior (39 items related to the shopping habits, reasons for discarding food, categories of discarded food, management routines of leftovers, cooking habits, and quantity of food waste), and (ii) socio-demographic characteristics (7 questions related to the gender, age, education, monthly household income, number of members in the family, number of children in the household and place of residency) (Table 1). To determine the behavior changes regarding household food waste management, the respondents were asked to evaluate their shopping habits, the reasons for discarding food, the frequency of discarding food, and the management routines of leftovers from two perspectives: before the COVID-19 pandemic and during the COVID-19 pandemic.

Table 1. Categories of collected data.

Variable	Adapted after
Shopping habits When you buy food before/during COVID-19 pandemic: do you check the food you have at home? (Q1/Q18) do you make a shopping list? (Q2/Q19) do you plan the menu for the next period? (Q3/Q20) do you make any plans (Q4/Q21) Answer options: 1. Never; 2. Most of the time, no; 3. Sometimes yes; sometimes no; 4. Most of the time, yes; 5. Always	Krisjanti [132] Lyndhurst et al. [133] Jörissen et al. [80] Mattar et al. [130] Mondejar-Jimenez et al. [134]
Reasons for discarding food Regarding the reasons for discarding food before/during the COVID-19 pandemic: are you cooking too much? (Q5/Q22) are you rarely going shopping and buying large quantities of food that expires? (Q6/Q23) are you buying food at short-term promotions? (Q7/Q24) do you make shopping plans? (Q8/Q25) do you throw away food? (Q9/Q26) Answer options: 1. Very rarely; 2. Rarely; 3. Neither rare nor often; 4. Often; 5. Very often	Bilska et al. [135] Quested et al. [19] Bravi et al. [67]
Frequency of discarding food by categories How often did you discard the following food categories before/during the COVID-19 pandemic? Fruits and vegetables (Q10/Q27) Meat and meat products (Q11/Q28) Bread and bakery products (Q12/Q29) Milk and dairy products (Q13/Q30) Answer options: 1. Very rarely; 2. Rarely; 3. Neither rare nor often; 4. Often; 5. Very often	Bilska et al. [135] Jörissen et al. [80] Mondejar-Jimenez et al. [134] Bravi et al. [63]
Management routines of leftovers Before/during the COVID-19 pandemic, how often did you: Use the leftovers to prepare other dishes? (Q14/Q31) Freeze the leftovers for later use? (Q15/Q34) Feed animals with the leftovers? (Q16/Q33) Throw away the leftovers? (Q17/Q34) Answer options: 1. Very rarely; 2. Rarely; 3. Neither rare nor often; 4. Often; 5. Very often	Bilska et al. [135] Stancu et al. [62] Farr-Wharton et al. [57] Quested and Johnson [136]; Silvennoinen et al. [20]
Cooking habits To which extent are you concerned about the following aspects since the pandemic started: I rarely order home-cooked food (Q35) I cook more (Q36) I buy instant products/pre-cooked products (Q37) I pay more attention to the information on the label (Q38) Answer options: 1. To an extremely small extent; 2. To a small extent; 3. Neutral; 4. To a large extent; 5. To an extremely large extent	Djekic et al. [137]
Quantity of food waste During the quarantine period, estimate the quantity of food that was discarded weekly into your household? (Q39) Answer options: 1. Less than 25%; 2. 25%–50%; 3. More than 50%	Jörissen et al. [80]
Socio-demographic characteristics of the respondents: Gender (Q40), Age (Q41), education level (Q42), Number of members in the family (Q43), Number of children in the house (Q44), Monthly average household income (Q45), Place of residency (Q46).	

3.2. Sample and Data Collection

The target population of this research was represented by the inhabitants from the North-West Development Region of Romania. The sample size was 784 respondents, the confidence level used was 95%, and the margin of error used was 3.5%. Two criteria were set for the sample inclusion: the age of the respondents (18–70 years old) and the place of residency (one of the six counties from North-West Development Region of Romania: Bihor, Bistrita-Nasaud, Cluj, Maramures, Satu-Mare, Salaj).

A pilot study with 30 consumers was conducted to test the validity of the measurement scale and the questionnaire's relevance. The Cronbach's alpha coefficient was calculated to test the internal consistency of the items. The results ($\alpha = 0.784$) were above the limit of 0.7, indicating a good consistency of the scale and reliability of the data.

Data were collected through a structured questionnaire-based survey during May–October 2020. The questionnaire was distributed via social networks. The questionnaire was applied online in order to respect the sanitary measures imposed by the COVID-19 pandemic. Before starting the survey, the participants were informed about the aim of the study and assured about the General Data Regulation Protection (GDPR). A total number of 1103 questionnaires were collected, of which 859 were validated.

The profile of the respondents is presented in Table 2. The majority of the respondents were women (61.1%), and the gender balance of the sample was not assured. This is not surprising since women are generally responsible for food purchasing and cooking at home [138,139]. When it comes to age, 29% of the respondents were between 18–29 years old, and around 74% of them were from urban areas and had university degrees. This could be explained by the limited internet access of the residents from rural areas [140]. In terms of household size, the sample was dominated by families with 2 members (30.8%) and without children in 48.7% of the cases. The families with children were mainly represented by those with 1 child (under 18 years old; 52.4%) (Table 2).

Table 2. Respondents socio-demographic profile.

Characteristics		Sample (%)
Gender	Female	61.1
	Male	38.9
Age	18–29 years	29.0
	30–39 years	24.1
	40–49 years	18.6
	50–59 years	14.9
	>60 years	13.4
Education level	Less than 8 classes	2.8
	High school	23.2
	University degree	74.0
Monthly net household income (RON)	<2800	19.9
	2801–4200	24.1
	4201–5600	19.7
	>5601	36.3

Table 2. *Cont.*

Characteristics		Sample (%)
No. of persons in the household 3.03 ± 1.236	1	7.2
	2	30.8
	3	29.0
	4	23.3
	5 or more	9.7
No. of children in the household (<18 years) 0.80 ± 0.914	0	48.7
	1	26.9
	2 or more	24.5
Place of residency	Rural	26.1
	Urban	73.9

3.3. Data Analysis

Data analysis was performed using the IBM SPSS 23.0 software package. The socio-demographic characteristics and the variables used to determine household food waste management were analyzed using descriptive statistics. The *t*-test was employed to identify any significant differences in terms of shopping habits, reasons for discarding food, categories of discarded food, management routines of leftovers, cooking habits, the quantity of food waste before the COVID-19 pandemic, and during the COVID-19 pandemic.

A multidimensional cluster analysis was applied to identify the groups of individuals with similar behaviors related to household food waste management during the COVID-19 pandemic [141]. A non-hierarchical K-means cluster method used 28 constructs out of 46 to determine the groups' profiles. The constructs included in the analysis are related to the shopping habits, reasons for discarding food, frequency of discarding food by categories, management routines of leftovers, cooking habits, the quantity of food waste during the COVID-19 pandemic, and socio-demographic characteristics. The starting point of the analysis consisted in standardizing all the variables included in the model. Furthermore, the significance of differences between the mean levels for each element in each identified cluster was tested using the one-way ANOVA test (significance at $p < 0.05$). The null hypothesis of mean value equality was verified using the ANOVA Fisher–Snedecor F test. This verification was carried out with a significance level of $p = 0.05$. The null hypothesis was rejected when $p < 0.05$. Thus the variables related to giving leftovers to animals, the number of children in the family, and the place of residency were removed from the final model. A preliminary analysis was conducted assuming 2, 3, and 4 expected clusters. The analysis indicated that the most accurate profile of grouping the segments into individual clusters was obtained when assuming 3 clusters. Differences between clusters in terms of socio-demographic variables were statistically analyzed using the one-way ANOVA test, followed by the Tukey HSD multiple comparison test or the Chi-square test (significance at $p < 0.05$) [141].

4. Results

4.1. Shopping Habits

The first objective of the research consisted in analyzing the impact of the COVID-19 pandemic on food consumers' shopping habits. The analysis of the shopping habits management revealed that, before the COVID-19 pandemic, 35.7% of the respondents were checking the food that they have at home, most of the time before going shopping, while 11.2% stated that they were always checking the food that they had home, before shopping (Figure 2, Table 3). Regarding this aspect, it was noticed that during the COVID-19 pandemic, the percentage of those that were checking most of the time the food that they

were had at home before going shopping increased to 39%, while those that were always checking provisions they had before shopping increased to 17%.

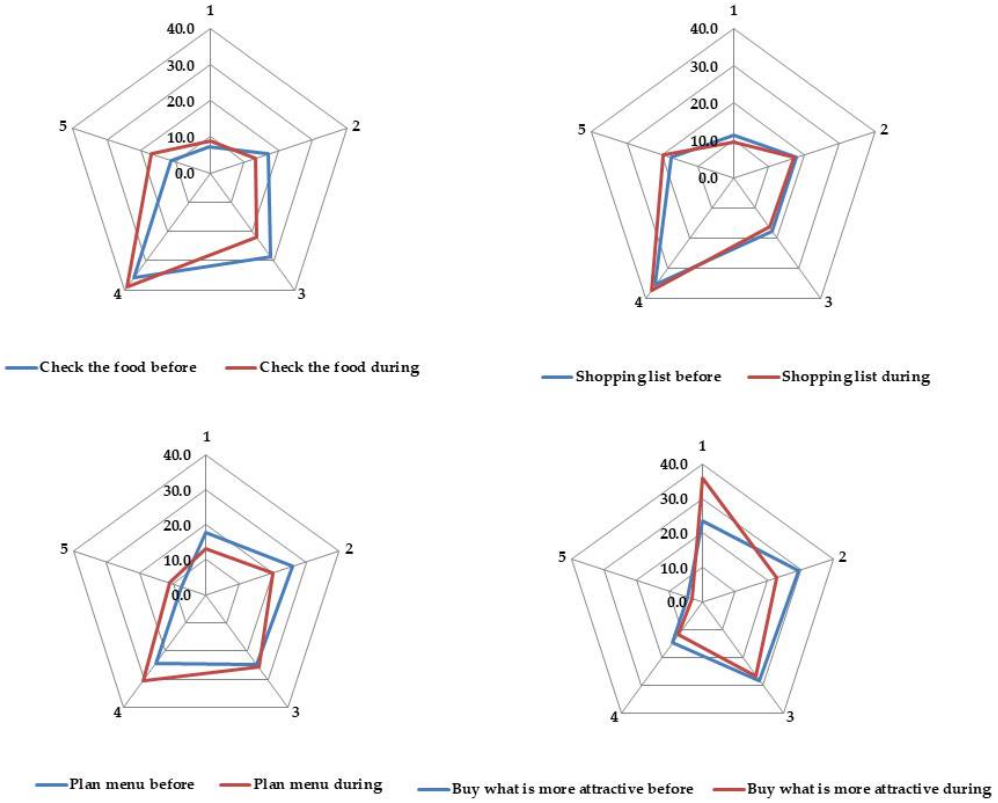

Figure 2. Comparative analysis of shopping habits.

Table 3. Shopping habits before the COVID-19 pandemic and during the COVID-19 pandemic.

Items	Before the COVID-19 Pandemic		During the COVID-19 Pandemic		*p*-Value
	Mean	SD	Mean	SD	
I check the food I have at home	3.28	1.094	3.42	1.174	0.001 **
I make a shopping list	3.30	1.263	3.41	1.244	0.075
I plan the menu for the next period	2.78	1.208	3.06	1.211	0.000 ***
I make no plans and buy what I find attractive	2.47	1.128	2.23	1.144	0.000 ***

** significant at 1% level, *** significant at 0.1% level.

Before the COVID-19 pandemic, 35.6% of the respondents declared that they were most of the time making a shopping list, while 17.3% declared that they were always making a shopping list. During the pandemic, the percentage of those that were most of the time making a shopping list increased to 37.3% and to 19.7% for those that were now always doing a shop. Analyzing how often the menu is planned for a longer period, it was noticed that 24.2% were doing this most of the time before the COVID-19 pandemic, against 30.4% during the pandemic. At the same time, before the COVID-19 pandemic, 7.5% of the respondents were always planning the menu for the next period, while 10.8% were always doing this during the pandemic.

In terms of buying instinct, before the state of emergency, the respondents were buying more often what they were finding to be attractive on the shelves (14.4%), compared with the situation during the pandemic, and 11.9% declared that they were buying what was attractive most of the time.

Significant differences were found for the habits of checking the food at home, planning the menu for the next period, and buying what consumers find to be attractive (Table 3).

4.2. Reasons for Discarding Food

The second objective of the research consisted in finding out which were the main reasons for food discarding. For both periods, the main reason was the fact that the respondents were cooking too much (Figure 3, Table 4). Before the COVID-19 pandemic, 26.8% of the respondents were very rarely throwing food away because they were cooking too much, but this percentage increased to 35.7% during the COVID-19 pandemic.

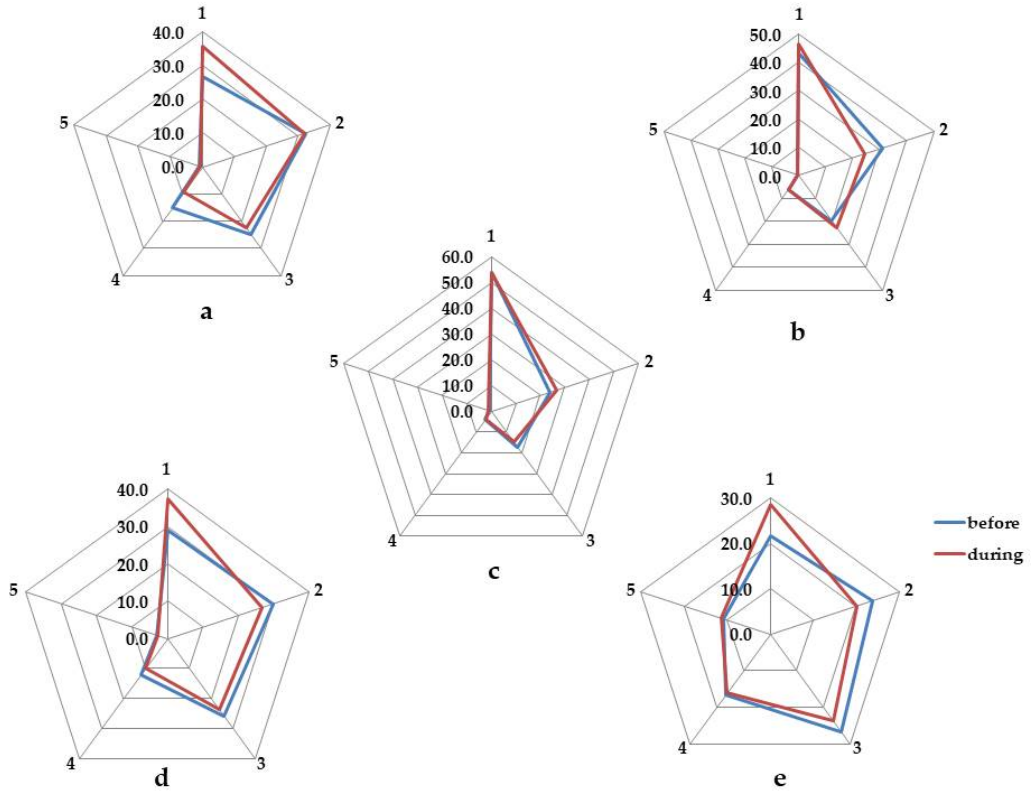

Figure 3. Comparative analysis reasons for food discharge (%). (**a**) cooking too much; (**b**) rarely going shopping and buying large quantities of food that expires; (**c**) buying food at short-term promotions; (**d**) not making shopping plans; (**e**) do not throw away food.

The percentage of those that often did not plan their shopping decreased from 12.1% to 9.9% between the two analyzed periods.

Table 4. Reasons for food discharge before the COVID-19 pandemic and during the COVID-19 pandemic.

Items	Before the COVID-19 Pandemic		During the COVID-19 Pandemic		*p*-Value
	Mean	SD	Mean	SD	
I am cooking too much	2.31	1.057	2.07	1.004	0.000 ***
I rarely go shopping and buy large quantities of food that expire	1.90	0.943	1.89	0.976	0.960
I buy food at short-term promotions	1.75	0.944	1.72	0.928	0.571
I do not make shopping plans	2.30	1.100	2.14	1.108	0.001 **
I do not throw away food	2.71	1.274	2.62	1.348	0.172

** significant at 1% level, *** significant at 0.1% level.

4.3. Categories of Food Waste

The third objective of the research consisted in identifying the frequency of discarding different food categories. To identify which type of food products are more thrown away, four main categories were analyzed: fruits and vegetables, meat and meat products, bread and bakery products, and milk and dairy products. It was noticed that 16.3% of the consumers declared that they were throwing away bread and bakery products more often than before the state emergency, reinforcing previous findings [64], while the percentage decreased to 10.1% during the pandemic (Figure 4). The reason for throwing away this category of food is because it is susceptible to stalling and spoiling [64]. Fruits and vegetables were the second most thrown away category of food (more than 10% of the consumers declared that they were at least often throwing away fruits and vegetables before the state of emergency), but it was recorded that a significant decrease of more than 5%, during the pandemic, although the wasting rate of fresh fruit and vegetables was still high in households [142]. Meat and meat products were the category that was less often thrown away. Due to the high prices of this category, people purchase lower amounts and are more attentive to the storage [64]. Around 58% of the consumers stated that they were very rarely throwing away meat and meat products before the COVID-19 pandemic, with an increase of more than 4% during the pandemic (Figure 3). A possible rationale could be that meat is frequently preserved frozen, increasing the availability period, but could also be related to the high prices of this category, determining people to purchase lower amounts and to be more attentive to the storage [64].

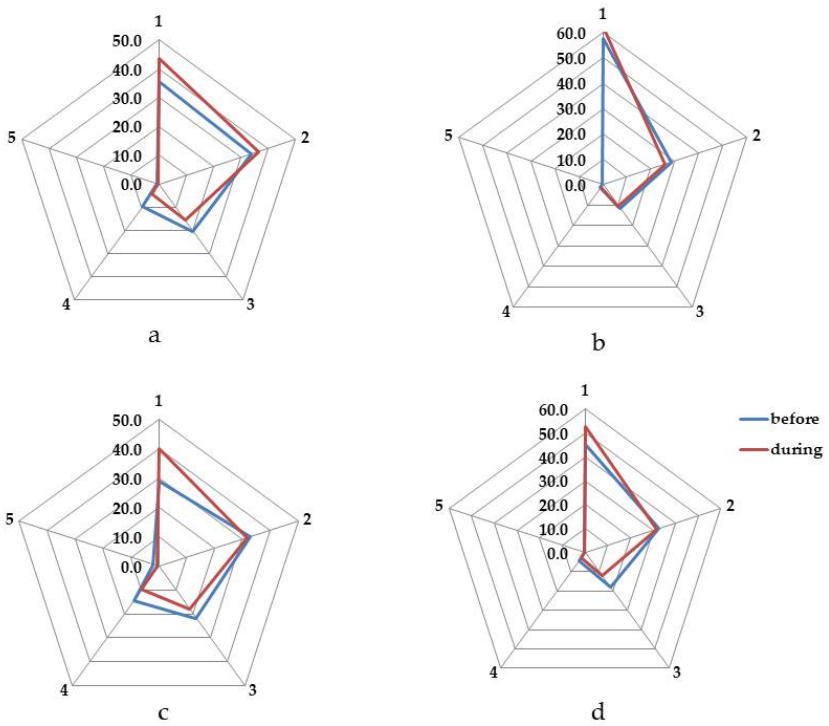

Figure 4. Categories of food waste (%). (**a**) fruits and vegetables; (**b**) meat and meat products; (**c**) bread and bakery products; (**d**) milk and dairy products.

The frequency of throwing away food products decreased between the two analyzed periods, with significant differences in the case of fruits and vegetables, bread and bakery products, milk and dairy products ($p < 0.001$) (Table 5). Bread and bakery products were the main categories of food products that were more often thrown away before the state of emergency (2.27 ± 1.093) and during the pandemic (1.99 ± 1.017).

Table 5. Categories of food waste before the COVID-19 pandemic and during the COVID-19 pandemic.

Category of Food	Before the COVID-19 Pandemic		During the COVID-19 Pandemic		*p*-Value
	Mean	SD	Mean	SD	
Fruits and vegetables	2.06	0.966	1.81	0.861	0.000 ***
Meat and meat products	1.58	0.780	1.51	0.733	0.056
Bread and bakery products	2.27	1.093	1.99	1.017	0.000 ***
Milk and dairy products	1.82	0.883	1.66	0.828	0.000 ***

*** significant at 0.1% level.

4.4. Management Routines of Leftovers

Another objective of the research consisted in analyzing the management routines of leftovers. Being asked how they valorized the food scraps, around 20% of the respondents declared that they often used the leftovers to prepare other dishes, while 5% reported they did so very often. The same trend was noticed in both analyzed periods. Freezing for later use was often an option for more than 15% of the consumers before the state of emergency, with a decrease of 3% during the pandemic (Figure 5). This could be a result of the fact that people were eating more at home, and they were not forced to preserve cooked food by freezing it.

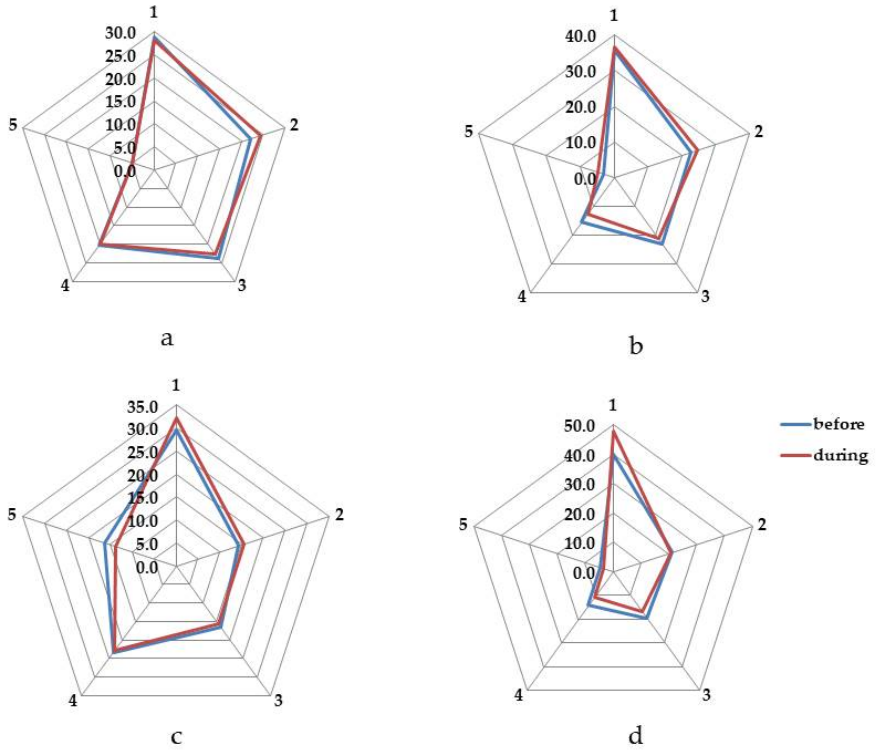

Figure 5. Ways of valorizing the food scraps (%). (**a**) prepare other dishes; (**b**) freezing for later use; (**c**) feeding animals; (**d**) throw away.

Feeding animals was the most often method of valorizing the scraps in both analyzed periods (Table 6). The results from Table 6 reinforce the idea that during the pandemic COVID-19, the consumers decreased the amount of the food losses ($p < 0.005$).

Table 6. Ways of valorizing the food scraps before the COVID-19 pandemic and during the COVID-19 pandemic.

Ways of Valorizing the Food Scraps	Before the COVID-19 Pandemic		During the COVID-19 Pandemic		*p*-Value
	Mean	SD	Mean	SD	
Use to prepare other dishes	2.50	1.236	2.49	1.229	0.848
Freeze for later use	2.28	1.186	2.24	1.204	0.493
Feed animals	2.83	1.477	2.7	1.462	0.088
Throw them away	2.23	1.234	2.01	1.185	0.000 ***

*** significant at 0.1% level.

4.5. Cluster Analysis

Furthermore, the cluster analysis employed on the 28 household food waste management items led to three groups of consumers: "The wasters" (n = 264), "The careless consumers" (n = 227), and "The careful consumers" (n = 359). There were significant differences among the three groups and their socio-demographic characteristics (p-value < 0.01) (Figure 6, Table 7).

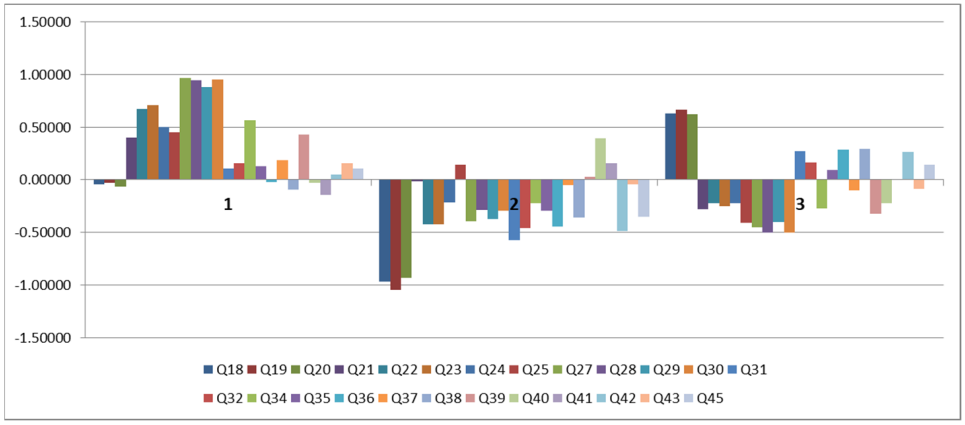

Figure 6. Final Clusters Centers.

Table 7. Comparative analysis of the Clusters.

Items	Cluster			*p*-Value
	1 (n = 264)	2 (n = 227)	3 (n = 359)	
Shopping habits				
Q18 I check the food I have at home	3.37 (0.910) b	2.29 (1.110) c	4.16 (0.729) a	0.000
Q19 I make a shopping list	3.37 (1.005) b	2.11 (0.999) c	4.23 (0.741) a	0.000
Q20 I plan the menu for the next period	2.97 (0.984) b	1.93 (0.909) c	3.81 (0.929) a	0.000
Q21 I make no plans and buy what I find attractive	2.69 (1.058) a	2.22 (1.183) b	1.91 (1.067) c	0.000
Reasons for discarding food				
Q22 I am cooking too much	2.75 (0.919) a	1.65 (0.814) c	1.85 (0.926) b	0.000
Q23 I rarely go shopping and buy large quantities of food that expire	2.59 (0.923) a	1.48 (0.737) bc	1.65 (0.879) b	0.000
Q24 I buy food at short-term promotions	2.18 (0.962) a	1.52 (0.899) b	1.51 (0.795) bc	0.000
Q25 I do not make shopping plans	2.64 (0.977) a	2.30 (1.251) b	1.68 (0.906) c	0.000

Table 7. *Cont.*

Items	Cluster			*p*-Value
	1 (*n* = 264)	**2 (*n* = 227)**	**3 (*n* = 359)**	
Categories of foods discarded				
Q27 Fruits and vegetables	2.64 (0.777) a	1.47 (0.647) b	1.42 (0.572) bc	0.000
Q28 Meat and meat products	2.20 (0.786) a	1.30 (0.531) b	1.14 (0.364) c	0.000
Q29 Bread and bakery products	2.89 (0.899) a	1.62 (0.734) b	1.59 (0.824) bc	0.000
Q30 Milk and dairy products	2.45 (0.826) a	1.42 (0.607) b	1.25 (0.481) c	0.000
Management routines of leftovers				
Q31 Use to prepare other dishes	2.62 (1.028) ab	1.79 (1.004) c	2.83 (1.313) a	0.000
Q32 Freeze for later use	2.43 (1.080) ab	1.69 (0.914) c	2.44 (1.335) a	0.000
Q34 Throw them away	2.69 (1.098) a	1.75 (1.110) b	1.70 (1.090) bc	0.000
Cooking habits				
Q35 I rarely order home-cooked food	3.04 (1.138) a	2.49 (1.348) c	3.00 (1.366) ab	0.000
Q36 I cook more	3.64 (0.949) b	3.16 (1.342) c	3.99 (0.988) a	0.000
Q37 I buy instant products/pre-cooked products	3.59 (0.880) b	3.51 (1.191) ac	4.09 (0.853) a	0.001
Q38 I pay more attention to the information on the label	3.44 (0.933) b	3.17 (1.186) c	3.84 (0.910) a	0.000
Q39 Quantity of food waste				$p < 0.001$
<25% (%)	194 (73.5%)	197 (86.8%)	362 (98.4%)	
>25% (%)	70 (26.5%)	30 (13.2%)	6 (1.6%)	
Q40 Gender				$p < 0.001$
Female	165 (62.5%)	95 (41.9%)	265 (72.0%)	
Male	99 (37.5%)	132 (58.1%)	103 (28.0%)	
Q41 Age		$p < 0.001$		
18–29 years	100 (37.9%)	52 (22.9%)	97 (26.4%)	
30–39 years	59 (22.3%)	56 (24.7%)	92 (25.0%)	
40–49 years	38 (14.4%)	36 (15.9%)	86 (23.4%)	
50–59 years	33 (12.5%)	49 (21.6%)	46 (12.5%)	
>60 years	34 (12.9%)	34 (15.0%)	47 (12.8%)	
Q42 Education level				
Less than 8 classes	3 (1.1%)	17 (7.5%)	4 (1.1%)	$p < 0.001$
High school	63 (23.9%)	88 (38.8%)	48 (13.0%)	
University degree	198 (75.0%)	122 (53.7%)	316 (85.9%)	
Q43 No. of members in the family	3.22 (1.289) a	2.97 (1.232) b	2.92 (1.186) bc	0.000
Q45 Monthly household income				$p < 0.001$
<2800 RON	38 (14.4%)	75 (33.0%)	58 (15.8%)	
2801–4200 RON	67 (25.4%)	60 (26.4%)	79 (21.5%)	
4201–5600 RON	56 (21.2%)	36 (15.9%)	78 (21.2%)	
>5601 RON	103 (39.0%)	56 (24.7%)	153 (41.6%)	

Scores within the same statement followed by different letters are significantly different (i.e., "a" is different from "b" but not from "ab").

The first group—"The wasters"—was comprised of people who were not concerned about planning the shopping sessions, rarely checked the food ahead, and rarely shopped based on a list. They preferred to buy food in large quantities at short-term promotions. The consumption of the food prepared was not always correlated with the cooked volumes or with the quantities of instant/pre-cooked products purchased, resulting in large quantities of food waste. They were used to throwing away leftovers from all four food categories. People from this group recorded the highest percentage of food waste. The respondents from this group had significantly larger families compared to other groups ($p < 0.05$) (Table 7).

The second group—"The careless consumers"—was represented by people who were least concerned about planning before going shopping. Although they expressed a more indifferent behavior, they threw away lower quantities of food than the first group of consumers. This was perhaps the result of the fact that they rarely cook too much and rarely buy large quantities of food or at short-term promotions. However, their shopping sessions were characterized as unorganized since they did not make shopping plans. This group was mainly represented by males (56.6%) and older people (36.6%).

The third group—"The careful consumers"—was the most organized one and preoccupied with the menu planning and shopping list, similarly to the group identified in Ireland [143]. At the same time, they paid attention to the product labels and cooked more. They chose to use leftovers to prepare other dishes or to freeze for later use, thus throwing away lower quantities. In terms of education, this is the more educated group. They also had the lowest number of children in their families.

5. Discussion

The study explored the dynamics of food waste management in Romanian households between two periods: before and during the COVID-19 pandemic. The actual study proved that the state of emergency during the COVID -19 pandemic really influenced the Romanian consumers' food shopping habits, similar to previous research results from other countries [103,144,145], but also offered important information regarding the connection between those habits and the global problem of food waste. The pandemic improved the Romanian consumers' shopping habits, as the percentage of those who check their food before going shopping increased. The situation was similar when it came to shopping lists: the percentage of those who made such lists during the COVID-19 pandemic increased as well, confirming previous findings [66,95,146]. Menu planning was also strongly connected to the shopping lists: more consumers decided to practice it during the pandemic.

The main reasons for Romanian consumers to discard food remained over-cooking, but, before the pandemic, the percentage of the respondents who threw food away due to the over-cooking was even higher, indicating a more rational behavior during the pandemic. Over-cooking was found to be the main reason for food disposal in other countries too [66]. It was also of great interest to find out the type of food products that are thrown away more often. An important finding is that the frequency of food disposal decreased for three categories out of four (fruits and vegetables, bread and bakery products, milk and dairy products), bread and bakery products was the category which continued to be the most discarded, while meat and meat products were the least thrown away, confirming a similar behavior in other countries [8,20,43,46,64,66,146–149]. This category of food products was identified as the most stocked during the pandemic [103]. These results indicate that the perishable products that are not suitable for freezing continue to be thrown away, even if in a smaller amount, while the food products that can be frozen were less thrown away. Besides the type of foods thrown away, the findings indicated a significant difference between the two periods in terms of food waste, proving that consumers' food habits became more sustainable. This is a positive phenomenon hoped to be further sustained by consumers and encouraged by authorities and other food actors in the long term. The main methods to valorize the food scraps by the Romanian consumers were the preparation of other dishes, freezing for later use, and feeding animals, which was a frequent practice in both analyzed periods, similarly to the Macedonian consumers [64]. The results indicate that during the pandemic, the consumers decreased the amount of the food losses, the same phenomenon observed by other scholars after conducting studies during crisis periods [66,145].

The identified groups reveal different food-wasting behavior among the Romanian consumers during the COVID-19 pandemic. The largest group was represented by the "Careful consumers". Consumers from this group were preoccupied with good household food management by preparing shopping lists and establishing the menu in advance, being interested in the food labels, and cooking more often, in a similar way as the Irish consumers from the "caring" cluster [143]. This group was also considered in a similar

study conducted in Turkey [112], but the Romanian cluster comprises the most educated people, with the lowest number of children. This finding contradicts the research results from other countries, considering that the educated people had higher incomes and less time for household management, thus generating more waste due to the expired products or due to inappropriate storage conditions [115,128], the results being more in line with previous research [129,130].

The smallest group, entitled "careless consumers", preferred to buy large quantities of food at short-term promotions, assuring the premises for food waste, even while using shopping lists.

The group named "wasters" refers to older people, especially men with poor household management, which often leads to food waste. A similar group of consumers was identified in Ireland, the "uncaring" cluster, people that do not make shopping lists and do not check the food they had before going shopping, which leads to food waste [143] or in Romania, the "careless people". The results contradict the Turkish findings again when it comes to socio-demographical characteristics. The Turkish segment comprises consumers between 30 and 40 years old, while in Romania, it is dominated by old people.

6. Conclusions

The empirical research reveals changes in the consumers' behavior related to food waste in the context of the COVID-19 pandemic. People tend to build habits over periods of time. Such patterns are also related to the leftovers. During the pandemic, the global populations were forced to adapt their lifestyles to various restrictive regulations, which also impacted their food consumption behavior. Such changes occurred in Romania, as well as in other countries [64,65,102–107]. In Romania, the changing behavior was due to several restrictions were imposed by the state during the lockdown and state of emergency [150–152], some with direct impact on food consumption habits such as reduced opening hours for grocery stores, filling out a form to leave the house, temporary closure of places to eat out. The findings of the current study support the hypothesis that people tended to change their food-wasting habits. Three different behavioral groups were shaped based on the shopping habits, reasons, and frequency to discard food, management of leftovers, and personal characteristics. Although people became more conscious about their shopping habits, certain groups did not improve their habits related to food waste management. The food supply chain actors and the decision-makers should focus on raising awareness about the importance of more sustainable consumption of food and on controlling the food waste, in particular when the most at-risk consumers are concerned [128]. The current study has several implications from a theoretical point of view, highlighting that food waste is a complex process that needs deeper research since there are several factors affecting food waste behavior [63]. Moreover, it emphasizes the changes in the consumers' behavior, due to the COVID-19 pandemic, from the purchase motivation stage until the final process of food consumption. A literature review made it possible to build a theoretical framework around the potential factors that shape the consumers' behavior. By using the cluster analysis, consumers were segmented based on identified factors whose effect during the pandemic crisis period was demonstrated.

This study is not without limitations since it focused on one development region. Further research could expand the research area in order to investigate whether there are any regional differences. At the same time, the current research did neither explore the variety of possibilities to reduce food waste nor the food waste impact on the environment and on the social wellbeing. Another limitation is related to the data collection, which could limit the contribution of different social categories to the final sample.

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