



Assessment of household food waste management during the COVID-19 pandemic in Serbia: a cross-sectional online survey

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Abstract

The Serbian government has taken several measures to prevent the spread of COVID-19. These measures may have led to a disruption of daily life and affected food-related behaviors. This paper investigates the state of food waste management in Serbia and COVID-19's direct effect on consumer awareness, food consumption, and food waste behaviors. The study is based on an online survey using a structured questionnaire administered in Serbian from May 13 until June 13, 2020, through the Google forms platform. A total of 1212 valid answers were collected, mainly from female, young, and high-educated people. The survey results suggested that (i) household food waste in Serbia is low and there is a positive attitude toward food waste prevention; (ii) food waste increased during the COVID-19 pandemic; (iii) consumers reduced the number of shopping trips and shopped more than usual during the pandemic. This study contributes to a better understanding of consumers' consumption habits and attitudes toward food waste to prevent and reduce it.

Keywords COVID-19 · Food behavior · Food consumption · Food shopping · Food waste · Serbia · Balkans

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Introduction

The food system faces different challenges in its transition toward sustainability, such as food insecurity (FAO et al. 2020) and food contamination (Pejin et al. 2012; WHO 2015). Nevertheless, in the context of increasing food demand due to the global population growth and extending pressures on natural resources, food loss and waste (FLW) is a growing global issue (FAO 2019, 2011; HLPE 2014). Food loss and waste (FLW) occur throughout the entire food supply chain, from harvesting to consumption. Food loss happens upstream of the food chain (e.g., harvesting, transport, storage, and processing), while food waste refers to food lost at retail and consumption levels (FAO 2011, 2019; HLPE 2014). According to FAO (2019), “Food waste is the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food services, and consumers.” Food wastage at the household level is “the food brought home or prepared at home but not consumed” (Grandhi and Appaiah Singh 2016, p. 474).

Food waste is influenced by several factors categorized into behavioral (e.g., planning and organizational practices,

shopping, and storing practices, etc.), personal (e.g., level of education, knowledge, and awareness, etc.), product (e.g., food and package properties), and societal factors (e.g., incomes, politics of food prices, etc.) (Roodhuyzen et al. 2017; El Bilali and Ben Hassen 2020). It has also been confirmed that food waste increase when consumers shop from large supermarkets rather than from small shops or local markets (Jörissen et al. 2015). These factors influence consumer behavior in a specific way and vary from one person to another, from one era to another (rural/urban), or from country to another. Although food waste is a global concern, the scope and nature of food waste differ substantially between countries (Roodhuyzen et al. 2017). Additionally, food waste is mainly the result of poor food-management routines and behavior. Food-related behaviors and routines such as planning, purchasing, storing, cooking, eating, and managing leftovers, significantly affect food waste performance (Schanes et al. 2018). Reducing FW is critical for economic, environmental, and social reasons, and it is imperative to have a greater comprehension of how the COVID-19 outbreak has altered household consumption, as well as FW patterns and behavior (WRAP 2020).

The COVID-19 pandemic has significantly disturbed household food buying, altered shopping habits, and affected food waste. Several voices have come forth to warn of COVID-19's destabilizing effect on agri-food systems and food consumption (Ben Hassen et al. 2020). Undoubtedly, due to the strict measures imposed by governments to mitigate the SARS-CoV-2 virus spread, food management and consumption patterns shifted drastically (Principato et al. 2020). The crisis caused by the COVID-19 outbreak has changed global waste generation mechanisms, resulting in unforeseen changes in waste composition and quantity (Kalina and Tilley 2020), especially in the case of food waste (Sharma et al. 2020). Household food waste generation can either increase due to panic buying or decrease if consumers better use stored food and leftovers (Aldaco et al. 2020). Indeed, on the one hand, at the onset of the outbreak, customers concentrated on stocking food to mitigate the risk of future shortages. Many reports of panic buying of nonperishable food products (e.g., pasta, rice, canned goods, flour, and frozen food) have been recorded worldwide (Baker et al. 2020). Panic buying increased household food waste generation, especially for perishable products, due to storage limitations, bad cooking habits, or overcooking (Cosgrove et al. 2021; Cranfield 2020).

On the other hand, the COVID-19 outbreak has created unanticipated possibilities for sustainable food production and consumption (Sarkis et al. 2020). Many consumers have embraced thriftiness and cut down on food waste during the coronavirus crisis. Several researches, in Italy (Principato et al. 2020), the USA (Babbitt et al. 2021; Rodgers et al. 2021), the UK (Waste and Resources Action Program (WRAP) 2020), Russia (Ben Hassen et al. 2021a), Japan

(Qian et al. 2020), Tunisia (Jribi et al. 2020), Lebanon (Ben Hassen et al. 2021b), Mexico (Vargas-Lopez et al. 2021), or Qatar (Ben Hassen et al. 2020) revealed that household food waste decreased. In fact, during the pandemic, households adopted a wide range of positive food management strategies, such as more pre-shop planning (e.g., making a list), better in-home food storage, and creative approaches to cooking/prep (e.g., batch cooking and using up leftovers). Overall, the COVID-19 pandemic improved food shopping performance and prompted a favorable behavioral shift vis-à-vis food waste (Jribi et al. 2020). Adopting these strategies is motivated by several factors: avoiding going to the shops, since shopping in a grocery store has a perceived risk; saving money; not wanting to run out of food, and having more time. Also, it might be because people stayed inside for more extended periods, allowing them to devote more time to kitchen chores without feeling rushed (Vargas-Lopez et al. 2021). However, as Jribi et al. (2020) highlighted, consumer behavior changes toward food waste are likely to be influenced more by the socioeconomic context of the COVID-19 lockdown (i.e., food availability, limited mobility, and loss of income) than by a pro-environmental concern.

As of May 15, 2021, Serbia has confirmed 705,185 confirmed cases of COVID-19 with 6646 deaths (WHO 2021). On March 6, 2020, Serbia confirmed its first case of COVID-19 (The Government of the Republic of Serbia 2020). Consequently, a state of emergency was declared on March 15. Later, Serbia adopted several containment measures to prevent the spread of COVID-19: nationwide lockdown, closure of nonessential business, closure of school and universities, remote work, etc. (Šantić and Antić 2020). However, these measures may have affected attitudes and behaviors related to food, such as food waste. Also, after several years of substantial growth, the Serbian economy had a recession of 3% in 2020 (World Bank 2020). Overall, Serbia is recognized as a medium food waste polluter when it comes to food waste quantities. However, there is no accurate information or official statistics on how much food is wasted in Serbia. According to the National Geographic Srbija (2020), 35 kg of food is thrown per capita per year. Djekic et al. (2019) suggest that, annually, Serbian households discard 198,712 tons of food waste associated with 687,346 tons of CO₂ emission. Overall, research on food waste in Serbia is scarce. Since the COVID-19 infection is new and we do not know how long it will last, there is a need for information and knowledge to assess its impacts on food consumption patterns. In this context, the present paper investigates the state of food waste in Serbia.

Accordingly, the present paper sought to achieve three major objectives: 1) to investigate the state of food waste management in Serbia and test the hypothesis that household food waste in Serbia is low and there is a positive attitude toward food waste prevention (H1); 2) To investigate the immediate impact of COVID-19 on consumer awareness and behaviors

related to food waste, and to test the hypothesis that consumers have increased their food waste during the pandemic (H2); and 3) to test the hypothesis that decreased grocery stores trips and increased stockpiling and panic buying, increased food waste during the COVID-19 pandemic (H3). Before we expose the results, we present our methodology.

Materials and methods

A sample of $n = 1212$ adults from Serbia completed a computer-assisted web interview (CAWI) online survey between May 13 and June 13, 2020, through the Google forms platform. The study targets the general adult population (age >18 years) in Serbia. We used the non-probability sampling method. The study adopted the snowball-sampling technique, and participants were asked to roll out the online questionnaire to their acquaintances and relatives. The survey administered in Serbian was disseminated through various communication channels such as social media (Twitter and LinkedIn) and email. Before participating in the study, all participants provided their digital informed consent for data sharing and privacy policy. The questionnaire consisted of 30 one-option and multiple choices questions structured in 8 different sections: 1) Socio-demographics; 2) Food purchase behavior and household food expenditure estimation; 3) Knowledge of food labeling information; 4) Attitudes toward food waste; 5) Extent of household food waste; 6) Economic value of household food waste; 7) Information needed to reduce food waste; 8) Food waste and shopping behavior during the COVID-19 lockdown. To assure the validity and reliability of the survey data, the questionnaire was pretested with 33 respondents.

The data were downloaded into the Statistical Package for Social Sciences (SPSS) version 25.0 for analysis. Data were analyzed using descriptive statistics (frequency and percentage) to summarize data and a nonparametric Chi-square (χ^2) test was applied in the inferential part. Chi-square tests of independence were used to test the association with the demographic variables. In addition, Pearson's coefficient of contingency was applied to examine the relationship between some categorical variables such as throwing away uneaten food and shopping frequency.

Results

Respondents' profile

According to Table 1, 68.56% of the respondents are women and 43.84% are married with children. Regarding occupation status, 73.68% of the participants were working (full-time or

part-time) and 18.81% were students. In addition, most of the respondents were in middle age (47.35% of them were 36 to 55 years old) and 30.69% of the households have four persons. The sample was highly educated, as 80.61% of the respondents possessed a master's or a Ph.D.

Table 2 provides detailed results about shopping behaviors (place of shopping, expenditure, shopping frequency, etc.). The results show that most of the respondents (59.5%) were shopping from hypermarkets and supermarkets. However, 21.9% of the respondents remained loyal to small shops due to their proximity to their residence. Meanwhile, 15.5% of the surveyed households buy food at local markets and a small percentage (3.1%) buy directly from producers. There were significant associations between the place for buying food and age ($\chi^2 = 47.77, p < 0.01$), occupation ($\chi^2 = 36.53, p < 0.01$), and household composition ($\chi^2 = 28.95, p < 0.01$) (Table 2).

Regarding shopping frequency, consumers in Serbia buy food relatively often. Nearly a third of households (29.8%) do this every day and 28.49% buy food twice a week. Overall, only 5% buy food less than once a week. The frequency of food purchases was significantly associated with household composition, age, and occupation (Table 2).

Moreover, 40% of the households usually spend 151–300 euros a week on food and 24% spend more than 300 euros. Meanwhile, 36% of households spend weekly less than 150 euros on food. There was also a highly significant association between the value of purchased food and age ($\chi^2 = 78.37, p < 0.05$), occupation ($\chi^2 = 70.66, p < 0.05$), and household composition ($\chi^2 = 132.55, p < 0.01$).

Further, the shopping list is used by 37.7% of the participants and another 45.2% use it occasionally. Using a shopping list is significantly associated with the household composition ($\chi^2 = 24.27, p < 0.01$). Finally, special promotions and discounts encourage 44% of the participants to buy and 43.7% occasionally respond to them. Significant associations were found between the attitude toward special promotions and respondent's age ($\chi^2 = 38.25, p < 0.01$), household composition ($\chi^2 = 27.64, p < 0.01$), and occupation ($\chi^2 = 17.47, p < 0.05$) (Table 2).

Quantities, types, and causes of food waste

According to Table 3, 46.04% of the respondents stated that they did not throw away food, 22.28% threw away less than 250 g per week, and 21.2% threw between 250 and 500 g per week. A significant amount of food, over 500 g per week, was thrown away by 10.48% of the participants. At the same time, there was a highly significant association between the amount of food thrown away and gender ($\chi^2 = 19.59, p < 0.01$) and household composition ($\chi^2 = 44.75, p < 0.01$) (Table 3).

As shown in figure 1, household food waste is moderate for all food groups. In addition, the results reveal that the most wasted food groups were cereals and bakery products, fruits,

Table 1 Sociodemographic characteristics of the participants ($n = 1212$)

Variable	Group/item	Frequency	% of respondents
Gender	Female	831	68.56
	Male	381	31.44
Age (years)	18 to 25	232	19.14
	26 to 35	276	22.77
	36 to 55	574	47.35
	56 and more	130	10.73
Education level	Primary and below	2	0.17
	Secondary	204	16.83
	Diploma/bachelor	29	2.39
	Master degree	685	56.52
	Higher education (PhD)	292	24.09
Occupation	In paid work (full time or part time)	893	73.68
	Student	228	18.81
	Unemployed	63	5.20
	Home duties	11	0.91
	Retired/age pensioner	17	1.40
	Household situation	Single person household	128
Living with parents		331	28.51
Married without children		168	14.47
Married with children		509	43.84
Shared household, non-related		25	2.15
Household members (number of people)	1	123	10.15
	2	222	18.32
	3	291	24.01
	4	372	30.69
	5	146	12.05
	6 and more	58	4.8

and vegetables. The least wasted food groups were fish and seafood, pulses and oilseeds, as well as meat and meat products.

Regarding the economic value of food waste, 36.04% of the participants throw away less than 5 euros worth of food per month, 52.61% between 5 and 25 euros, and 11% throw away more than 25 euros. The economic value of the wasted food was significantly associated with the household composition ($\chi^2 = 31.08$, $p < 0.01$) and gender ($\chi^2 = 8.84$, $p < 0.05$) (Table 3).

Further, shopping frequency and household food expenditure per month impacted some food waste-related behaviors such as cooking a main meal from main raw ingredients and frequency of throwing away leftovers (Table 4).

Regarding knowledge of expiry time and labeling (Table 5), most of the respondents do not have the proper knowledge about the most used types of labels, namely “use by” and “best before”¹.

¹ According to the EU regulation 1169/2011, “use-by” and “best before” dates are the two most used types of labels. The label “use-by” is used for highly perishable food and indicates minimum durability of food, and after that date, food may no longer be safe to eat. The label “best before” means that past that date food may be safe to eat, but its quality may have deteriorated (EC 2011).

Indeed, regarding the label “use-by,” only 49% of the respondents know that food must be eaten or thrown away by this date. Only 22.35% of the respondents know that with the label “best before,” food is still safe to eat after this date if it has not been damaged or deteriorated. A significant association exists between the knowledge about the label “use by” and household composition ($\chi^2 = 25.75$, $p < 0.01$) and between the knowledge about the label “best before” and gender ($\chi^2 = 10.98$, $p < 0.01$). For both labels, there is a significant association with age (Table 5).

Regarding the attitude toward food waste, a high percentage of the participants are concerned about food waste (89.44%), with significant associations with age ($\chi^2 = 37.45$, $p < 0.01$), occupation ($\chi^2 = 28.43$, $p < 0.01$), and household composition ($\chi^2 = 53.98$, $p < 0.01$). Moreover, 60% of the sample throw “almost nothing” and “very little” uneaten food. (Table 6). In addition, the population in Serbia shows moderation in the frequency of food wastage because most respondents (63%) throw food less than once a week and 30% more often. Household size ($\chi^2 = 29.6$, $p < 0.01$) had a significant association with this variable (Table 6).

Table 2 Food shopping behavior ($n = 1212$)

Variables	Frequency	Percentage	Gender		Age		Education		Occupation		Household composition	
			χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value
Market place			1.42	0.700	47.77**	0.000	20.03	0.067	36.53**	0.000	28.95**	0.004
Hypermarket/supermarket	721	59.49										
Mini-market/small market	265	21.86										
At the market	188	15.51										
Directly from producers	38	3.14										
Shopping frequency			9.71	0.084	32.00*	0.043	23.53	0.264	37.16*	0.011	43.20**	0.002
Every day	361	29.81										
Once every 2 days	291	24.03										
Twice a week	345	28.49										
Once a week	163	13.46										
Every 2 weeks	42	3.47										
Once a month	9	0.74										
Household food expenditure per month			7.62	0.106	78.37**	0.000	11.45	0.781	70.66**	0.000	132.55**	0.000
Up to 50 Euros	37	3.07										
51–100 Euros	111	9.20										
101–150 Euros	286	23.70										
151–300 Euros	483	40.02										
More than 300 Euros	290	24.03										
Use of a shopping list			5.24	0.073	12.89	0.116	7.99	0.435	5.85	0.664	24.27**	0.002
Yes	457	37.71										
No	207	17.08										
Sometimes	548	45.21										
Attraction to special offers			3.72	0.155	38.25**	0.000	11.05	0.199	17.47*	0.026	27.64**	0.001
Yes	536	44.22										
No	146	12.05										
Sometimes	530	43.73										

** $p < 0.01$, * $p < 0.05$

Further, the population in Serbia eats a lot at home. Only 1% of our cohort does not cook the main meal at home, and 99% do it with varying frequency. Around 10% of the respondents do it every day, and 71% three to six times a week. Gender, occupation, and household composition are significantly associated with cooking (Table 6). Reducing food waste is influenced by the fact that many households eat leftovers from the previous day several times a week (3–6 times, 30.7%; and less than twice, an additional 64.1%). As expected, the size of the household had a highly significant effect on this practice ($\chi^2 = 49.55$, $p < 0.01$) (Table 6).

Contrary to those who cook, a small percentage of our cohort eat in restaurants, 28.5% never do it and 0.75% do it more than ten times a week. The majority of the population is in the “golden mean” and eats less than twice a week in restaurants (60%) or more often (about 11%). Gender, age, and

household composition ($p = 0.000$) have highly significant interactions with going to restaurants, and occupation also has a significant influence at $p < 0.05$ (Table 6).

Change in consumer food habits during the COVID-19 pandemic

Since the survey was conducted during the pandemic, a special group of questions was dedicated to the changes in food consumption, shopping, and waste, during the outbreak and psychological pressure due to the risk of SARS-CoV-2 virus infection (Table 7).

Slightly more than a third of respondents go shopping less often than before. Furthermore, approximately one-third of consumers buy more food than usual (24.6% more and 5.5% much more), which might denote panic buying and food

Table 3 Amount and economic value of food waste (*n* = 1212)

Respondents	Frequency	Percentage	Gender		Age		Education		Occupation		Household composition	
			χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value
Consumable food throws away per week			19.59**	0.001	20.32	0.438	15.79	0.729	16.21	0.704	44.75**	0.001
I do not throw away	558	46.04										
Less than 250 gr	270	22.28										
Between 250 and 500 g	257	21.20										
Between 500 g and 1 kg	87	7.18										
Between 1 kg and 2 kg	28	2.31										
More than 2 kg	12	0.99										
Economic value of food wasted per month			8.84	0.032*	14.56	0.266	8.99	0.704	17.13	0.145	31.08**	0.002
Less than 5 euros	435	36.04										
5–25 euros	635	52.61										
25–50 euros	109	9.03										
More than 50 euros	28	2.32										

***p* < 0.01, **p* < 0.05

stockpiling behaviors among Serbian consumers following the outbreak of COVID-19. This behavior has undoubtedly been influenced by limited movement and panic over food shortages. Approximately proportional to the increase in food supplies, the quantities of food thrown away also increased. During the COVID-19 outbreak and lockdown, 26.7% of the respondents confirmed throwing more food and only 8.1% threw less or much less.

Discussion

This paper investigated the state of food waste management in Serbia and the immediate impact of the COVID-19 pandemic on Serbian consumer awareness, attitudes, and behaviors related to food consumption, food shopping, and food waste. The research highlighted several key consumer trends that are

currently shaping food consumption habits, food waste patterns as well as food purchasing behavior in Serbia.

First, in Serbia, food is mainly bought in hyper/supermarkets, as in most countries in the Western Balkans region (Berjan et al. 2019; Bogevska et al. 2020; Preka et al. 2020), because supermarkets have become dominant in global food supply chains (Machado et al. 2017) and “buying in this type of store has an element of pleasure” (Farhangmehr et al. 2000). The place of purchase of food affects the individual purchased quantities of food. Regarding buying frequency, more than half of our cohort goes shopping every two days, which certainly affects the amount of food thrown away. Rationality in shopping can be achieved by following a pre-prepared list, but only about a third of the participants do it. Moreover, we noticed some differences in sociodemographic factors, such as the value of purchased food, age, occupation, and household composition. Undeniably, as observed in Japan by Qian et al. (2020), larger families and younger people tend to purchase excessive food. Households with children are more likely to buy more food than single-person households or couples without children. Also, older individuals have a greater awareness of household food waste and consequently buy less food than younger adults. Individuals who are 65 or older have been shown to engage in food waste-reducing practices such as meal preparation in advance and having a greater understanding of food waste than younger adults (Questa et al. 2013). Also, the difference in occupation implies variance of income and lifestyle. Individuals in paid work (full-time or part-time) have more income and consequently tend to buy more food than students, unemployed, etc.

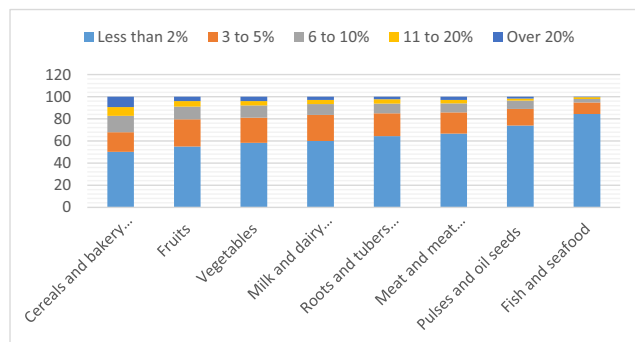


Fig. 1 Estimation of household waste by product group (percentage)

Table 4 Impact of shopping frequency and food expenditure on some food waste behaviors (*n* = 1212)

Variables	Shopping frequency		Household food expenditure per month	
	C ^a	<i>p</i> -value	C ^a	<i>p</i> -value
Throwing away uneaten food	0.173	0.01*	0.155	0.021*
Frequency of throwing away leftovers	0.149	0.03*	0.147	0.009**
Cooking a main meal from main raw ingredients	0.178	0.006**	0.217	0.000**
Eating a meal leftover from a previous day	0.109	0.814	0.110	0.55
Eating at a restaurant	0.117	0.675	0.141	0.090

***p* < 0.01, **p* < 0.05
^aPearson’s coefficient of contingency

Second, consistent with our hypothesis H1, the results showed that household food waste in Serbia is low, as in most developing countries in the Balkan region (Berjan et al. 2019; Bogevska et al. 2020; Vaško et al. 2020; Yildirim et al. 2016) and less than what Djekic et al. (2019) determined for Serbia in 2019. FW in Serbia is significantly lower than in developed countries [e.g., from 21% (Gunders 2012) to 30% (Yu and Jaenicke 2020) in the US, 22% in the UK (WRAP 2020), and 21–35% in the EU (Caldeira et al. 2019)], taking into account the limitations regarding different methodologies used for FW calculations (Bräutigam et al. 2014) and that there are differences between studies and in the reliability of data (Corrado and Sala 2018). Further, the most wasted food groups were cereals and bakery products, fruits, and vegetables. Due to their specific physiological and

microbiological characteristics, fruits and vegetables are highly perishable products that can end up in the bin if they are not adequately preserved. Because it is susceptible to stalling and spoiling, consumers find that old bread is less attractive than fresh. These results confirm those observed in Serbia by Djekic et al. (2019) and other European countries such as UK (Quested et al. 2011) and Switzerland (Visschers et al. 2016).

Third, most participants cook meals from fresh ingredients several times a week and have developed cooking skills. This contributes to harmonizing the size of prepared meals to the household’s size and reducing the ingredients’ wastage. In addition, it is a common practice in Serbia to store and eat leftovers during the next few days. This habit might probably be driven more by socioeconomic factors than by a pro-

Table 5 Knowledge about food labeling (*n* = 1212)

Variable	Frequency	Percentage	Gender		Age		Education		Occupation		Household composition	
			χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value
Knowledge of labeling (use by)			2.06	0.358	19.40*	0.013	9.22	0.324	13.56	0.094	25.77**	0.001
Foods must be eaten or thrown away by this date	585	48.99										
Foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished	558	46.73										
Foods must be sold at a discount after this date	51	4.27										
Knowledge of labeling (best before)			10.98**	0.004	16.36*	0.038	13.62	0.092	7.16	0.519	10.37	0.240
Foods must be eaten or thrown away by this date	892	74.40										
Foods are still safe to eat after this date as long as they are not damaged, deteriorated, or perished	268	22.35										
Foods must be sold at a discount after this date	39	3.25										

***p* < 0.01, **p* < 0.05

Table 6 Attitude toward food waste (*n* = 1212)

Variables	Frequency	Percentage	Gender		Age		Education		Occupation		Household composition	
			χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value
Self-description			5.12	0.163	37.45**	0.000	10.53	0.570	28.43**	0.005	53.98**	0.000
I worry about food waste, and I try to avoid it whenever I can	1084	89.44										
I am aware of the problems associated with food waste, but I do not think I will change my behavior in the near future	100	8.25										
I was interested in the issue of food waste in the past, but now I do not care	5	0.41										
I do not consider food waste as a crucial problem	23	1.90										
Throwing away uneaten food		0.00	3.13	0.537	12.17	0.732	29.94*	0.018	16.03	0.451	26.13	0.052
Much more than it should	56	4.62										
More than it should	149	12.29										
A reasonable amount	280	23.10										
Very little	496	40.92										
Almost nothing	231	19.06										
Frequency of throwing away leftovers		0.00	3.68	0.299	11.49	0.487	7.84	0.797	20.68	0.055	29.60**	0.003
Never	81	6.68										
Less than one time a week	765	63.12										
From 1 to 2 times a week	286	23.60										
More than twice a week	80	6.60										
Cooking a main meal from main raw ingredients			22.82**	0.000	26.16	0.052	13.76	0.617	32.18**	0.009	118.00**	0.000
Never	11	0.91										
Less than twice a week	188	15.59										
Three to six times a week	861	71.39										
Seven to ten times a week	109	9.04										
More than ten times a week	37	3.07										
Eating a meal leftover from a previous day			2.04	0.728	24.30	0.083	14.58	0.556	15.74	0.471	49.55**	0.000
Never	38	3.18										
Less than twice a week	767	64.13										
Three to six times a week	367	30.69										
Seven to ten times a week	17	1.42										
More than ten times a week	7	0.59										
Eating at a restaurant			15.58**	0.004	41.41**	0.000	26.30	0.050	28.45*	0.028	97.71**	0.000
Never	340	28.50										
Less than twice a week	721	60.44										
3 to 6 times a week	104	8.72										
7 to 10 times a week	19	1.59										
More than 10 times a week	9	0.75										
Using ready-made meals			11.20*	0.024	18.89	0.274	8.15	0.944	59.94**	0.000	54.75**	0.000
Never	712	59.78										
Less than twice a week	422	35.43										
Three to 6 times a week	46	3.86										
7 to 10 times a week	9	0.76										
More than 10 times a week	2	0.17										

***p* < 0.01, **p* < 0.05

Table 7. Changes in food purchase and wastage behavior during the outbreak of COVID-19 and lockdown ($n = 1212$)

Item	Frequency	Percentage	Gender		Age		Education		Occupation		Household composition	
			χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value	χ^2	<i>p</i> -value
What has changed in your shopping behavior during the outbreak of COVID-19 and lockdown?			5.08	0.079	19.63	0.012	12.11	0.15	9.47	0.304	8.00	0.43
I buy online	60	5.0										
I rarely go shopping	444	36.9										
I'm going shopping like I used to	699	58.1										
What has changed in the extent of your purchase during the outbreak of COVID-19 and lockdown?*			2.82	0.58	18.85	0.28	34.39	0.005	26.58	0.046	8.72	0.92
I buy a lot less than usual	14	1.2										
I buy less than usual	86	7.1										
I buy as same as usual	746	61.6										
I buy more than usual	298	24.6										
I buy a lot more than usual	67	5.5										
How has your food wastage changed during the outbreak of COVID-19 and lockdown?***			11.27	0.24	31.18	0.013	14.81	0.54	15.21	0.51	31.35	0.12
It has become much less	23	1.9										
Less	75	6.2										
Has not changed	758	62.5										
More	324	26.7										
Much more	32	2.6										

*Scale: I buy a lot less than usual = 1; I buy less than usual = 2; I buy as same as usual = 3; I buy more than usual = 4; I buy a lot more than usual = 5.

**Scale: It has become much less = 1; less = 2; has not changed = 3; more = 4; much more = 5

environmental concern. A similar practice has been observed in other low-income countries such as Egypt (Elmenofi et al. 2015), Morocco (Abouabdillah et al. 2015), Lebanon (Charbel et al. 2016), Tunisia (Sassi et al. 2016), Montenegro (Berjan et al. 2019), Bosnia and Herzegovina (Vaško et al. 2020), and North Macedonia (Bogevska et al. 2020). Regarding food labeling knowledge, we observed confusion about the interpretation of food labels. This is not a unique case, and consumer confusion has been found in other studies (Secondi 2019; Zielińska et al. 2020), as well as calls on national regulations to reconcile food waste and food safety in labeling packaged food (Newsome et al. 2014).

Finally, a high percentage of participants are concerned about food waste (89%) and their actions regarding food handling and food waste amount confirm this concern. However, there is room for practices improving in food management, especially in educational campaigns for the correct interpretation of labels and better planning of procurement and storage of food to prevent its deterioration. Also, the use of food waste and leftovers for composting and energy production are practices that should be used more in the future, as is already the case in more developed countries.

These are many social norms that lead to behavior changes toward food waste, as Stöckli et al. (2018) recommended.

The COVID-19 pandemic led consumers during the outbreak and lockdown to go shopping less often, buy larger quantities of food, and, consequently, throw away more food than before the pandemic, which confirms our hypothesis H2. Indeed, as observed in several countries, consumers decreased the frequency of shopping trips and were shopping fewer than usual, spending more on each trip to limit supermarket visits, thereby controlling their perceived risk of exposure to COVID-19 (Cranfield 2020). In Serbia, leading retail chains witnessed a 20% increase in household consumption. Also, during March 2020, the opening hours of supermarkets in Serbia were reduced to contain the spread of the SARS-CoV-2 virus (Danas 2020). Accordingly, consistent with our hypothesis H3, the increase of household food waste in Serbia during the pandemic may be triggered by panic buying.

The main limitation of this research is the sample bias. The survey participants were selected at random and recruited voluntarily (cf. self-selection of the sample). The overrepresentation of women and educated individuals jeopardized the sample's representativeness and, as a result, the degree to which

results could be generalized to the whole adult population in Serbia. We believe this is related to the cultural context in Serbia and the Balkans in general, where women are in charge of cooking and food management in most households. Consequently, women were more interested in participating in the survey. Furthermore, persons who are not web-literate, as well as the elderly, are often excluded from online surveys. The limitations described above are prevalent in CAWI, frequently used in surveys (Couper 2000; Evans and Mathur 2018; Monzon and Bayart 2018). However, due to the COVID-19 pandemic, online surveys can collect data remotely, a significant benefit when social distancing is necessary, and face-to-face interviews are impossible and/or unsafe.

Conclusions

The study identified many consumer trends that presently affect Serbians' food consumption habits, food waste patterns, and food shopping habits. First, the results showed that household food waste in Serbia is low and there is a positive attitude toward food waste prevention. Second, most participants cook meals from fresh ingredients several times a week and have developed cooking skills. In addition, it is a common practice in Serbia to store and eat leftovers during the next few days. Third, regarding food labeling knowledge, we observed confusion about the interpretation of food labels. Hence, an appropriate media campaign should be conducted to bring consumers' attitudes and behaviors in line with food safety standards. Finally, the COVID-19 pandemic led consumers to go shopping less often, buy larger quantities of food, and, consequently, throw away more food than before. The increase of household food waste in Serbia during the pandemic might have been triggered by panic buying. This suggests that raising consumers' awareness through effective, multichannel information and communication campaigns, as well as ensuring a regular supply of agri-food markets, is fundamental to prevent household food wastage during crisis situations such as pandemics.

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Declaration

Ethics approval and consent to participate This study was performed in compliance with the Helsinki Declaration guidelines. The Western Michigan University Human Subjects Institutional Review Board (HSIRB) approved all procedures relevant to study participants. Participation in the research was voluntary. At the beginning of the study, each participant was informed of the study objective and context and provided their written informed consent regarding privacy and information management policies.

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