



## Has COVID-19 lockdown changed consumers' behavior with food and food waste?

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### KEY CONTRIBUTION

The COVID-19 pandemic has a direct impact on food systems by food safety and food security. The COVID-19 pandemic has jeopardized the activities of many countries to reduce food losses and waste. As a result of changing behavioural patterns, consumers could adjust their food behaviour and plan meals better, combined with generally better food management in the household. COVID-19 lockdown positively influenced food households' behaviour since food waste during lockdown has been reduced.

### ABSTRACT

The COVID-19 pandemic has not only had an enormous impact on human health but has also led to sudden changes in lifestyle due to physical distance and isolation at home, with social and economic consequences, and has disrupted every aspect of people's everyday life. With the spread of the virus to certain geographical regions, households' behaviour under its influence has changed significantly. For example, a pandemic proclamation has dramatically increased the purchase of food in households' attempts to store their supplies as well as paying more attention to food hygiene than before. As most countries in the world were closed, almost all food was consumed in households. The aim of this study was to answer the food safety question: Has COVID-19 lockdown changed consumer behaviour with food handling and food waste? Based on the results of an online survey of 1024 Croatian consumers on their behaviour when buying, preparing, and throwing food during lockdown, it can be concluded that COVID-19 lockdown positively influenced food households' behaviour since food waste during lockdown has been reduced. Most of the respondents stated that they threw away less than 10% of the food during the lockdown than they normally waste. They tended not to waste food and took measures to prevent it from happening. They only wasted food that was spoiled. When wasting food, respondents pointed out that they felt terrible, because they thought that all food should be used, especially in times of uncertainty caused by lockdown. Moreover, they did not overeat and gain weight, but rather waste excess food.



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## Introduction

A new coronavirus was discovered in China in late 2019 and was named SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2). This new strain of coronavirus has not been previously detected in humans. The virus causes a disease called COVID-19 with the most common symptoms of fever, dry cough and fatigue in most patients and viral pneumonia in much smaller numbers (Bai et al., 2020). The infection is transmitted in contact with an infected person by droplets from the mouth and nose when speaking, coughing or sneezing, which reach the mucous membrane of the nose, mouth or eyes directly. Recent studies also indicate airborne (respiratory) transmission, but still without reliable confirmation. The SARS-CoV-2 virus can be stable in the air for about 3 hours, on cardboard for 24 hours and on plastic and stainless steel for 2 to 3 days (van Doremalen et al., 2020). Due to the relatively quick and easy spread of the virus among humans, as well as the genetic diversity and numerous mutations of the SARS-CoV-2 virus (Phan, 2020), the World Health Organization declared a global pandemic on March 11, 2020 (WHO, 2020), which has created unprecedented circumstances in the recent history of mankind. In the absence of effective pharmaceutical solutions for prevention or treatment, the main control strategy of COVID-19 focuses on social interventions aimed at minimizing the transmission of the virus from person to person through physical distance. Intensive prevention measures were implemented in all countries, including early detection of patients and identification of people potentially exposed to infection, as well as restrictions on movement and gatherings and the elimination of traffic lines, with a message to citizens to stay at home and to employers to allow work from home.

As the new coronavirus spread rapidly, the impact of the pandemic COVID-19 on global agricultural and food markets became increasingly clear and the global health crisis evolved into a global food crisis (FAO, 2020a), underlining the fact that food was not a commodity like any other (IPES-Food, 2020). Global lockdowns affected the harvesting, production, processing, and transport of food, as well as logistics in general (Petetin, 2020). The COVID-19 pandemic had a direct impact on food systems by influencing supply and demand for food, and an indirect impact by reducing purchasing power and capacity to produce and distribute food (FAO, 2020b; OECD, 2020).

An additional challenge was to ensure food security and sustainability in a world where one third of all food produced for human consumption was lost or wasted every year (FAO, 2013), with households being the largest producers of food waste in developed countries. According to the United Nations Environment Program (UNEP) Food Waste Index Report 2024, in 2022 the world wasted 1.05 billion tons of food, most of which, 631 million tonnes or 60%, came from households (UNEP, 2024).

Of the 59 million tons of food waste produced annually in the European Union, around 54% came from households, which was an average of 72 kilograms per capita (Eurostat, 2024). In Croatia, this figure was somewhat lower, and it was estimated that an average of 71 kilograms of food waste was generated per capita annually, with most of the waste, around 76%, generated in households (European Commission, 2024). At the household level, about half of wasted food was fruit and vegetables (Ilakovac et al., 2020). Factors that affected the production of food waste in households under normal living conditions related to over-purchasing (Koivupuro et al., 2012; Graham-Rowe et al., 2014; Ganglbauer et al., 2015; Porpino et al., 2015; Stancu et al., 2016), poor planning (Stefan et al., 2013; Principato et al., 2015), inadequate storage (Romani et al., 2018; Principato et al., 2021), and misjudgements of the quantity of prepared meals (Koivupuro et al., 2012; Williams et al., 2012; Porpino et al., 2015), as well as situational factors and socio-demographic characteristics of households, such as underage children in the household (Parizeau et al., 2015; Ilakovac et al., 2020). Under the new circumstances of the pandemic, new threats of food spoilage and waste emerged, and The Food and Agriculture Organization of the United Nations

(FAO) called for efforts to feed the growing number of people financially affected by the COVID-19 pandemic response measures by recovering and redistributing surplus food supplies (FAO, 2020c). The COVID-19 pandemic jeopardized the activities of many countries to reduce food losses and waste. The closure of borders led to a shortage of seasonal workers in agriculture; the closure of much of the hospitality industry, hotels, and schools also resulted in the loss of markets for producers, and the segments of the supply chains for perishable food, vegetables, and milk became particularly challenging (FAO, 2020c). Due to physical distance measures and the lack of experienced staff, it became difficult to donate surplus food to food banks and charities. Sources of donations reduced due to consumers' panic buying, since supermarkets, often the main donors to food banks, struggled to keep their shelves full and were unable to donate food (FAO, 2020c; Nicola et al., 2020). Nevertheless, a large proportion of the food purchased by households may never have been consumed and could have ended up being disposed of as food waste because of a misunderstanding of date marking ("best-before" and "use by") and improper storage of these food items in households. On the other hand, responses to this crisis in the context of food safety showed significant progress in improving hygiene habits, such as washing hands, food, kitchen utensils, and surfaces where food was prepared and stored in households (Haas et al., 2020), as well at the food business operator level (Djekić et al., 2021). This was an additional response to instructions communicated by the competent authorities for the prevention of infection. For the above reasons, the United Nations called for an urgent rethink of the way food was produced, processed, marketed, consumed, and ultimately wasted (UN, 2020). The unsustainability of current food systems, further threatened by the COVID-19 pandemic, affected the achievement of the UN's global goals of sustainable development, particularly goal 2, Zero hunger, to achieve food security and improved nutrition, and goal 12, to halve per capita global food waste at the retail and consumer level and reduce food losses along production and supply chains by 2030.

Society's responses to the crisis needed to be effective and efficient. The view held by Galanakis (2020) implied innovation in the production of acceptable and economically competitive products and the development of functional foods fortified with bioactive compounds and antioxidants that promoted health and supported consumers' immune systems. Access to safe, nutritious, and affordable food remained a fundamental element of food security (Hobbs, 2020).

The COVID-19 pandemic not only had a huge impact on human health but also abruptly turned traditional lifestyles upside down through physical distance and domestic isolation, with social and economic consequences (Di Renzo et al., 2020). Like other crises, it had a major impact on lives by completely changing routines (Boons et al., 2020; Cranfield, 2020). At the time the first case of coronavirus infection was confirmed in Croatia on February 25th, citizens rushed to the shops to stock up on basic foodstuffs. In the first week of the virus's occurrence in Croatia, some food products (such as yeast, flour, oil, and canned food) temporarily sold out, but the shops remained in stock throughout the coronavirus crisis. Although the grocery stores were open, their working hours significantly reduced, and the number of customers in them was strictly limited, while maintaining physical distance between individuals. In addition, the authorities recommended reducing the number of purchases and allowed only one person from the household to shop.

The coronavirus crisis in Croatia highlighted an important food supply problem. Although Croatia had all the natural preconditions for food production, it did not produce enough for its own needs and was not self-sufficient in almost any agricultural crops, relying on imports from other countries, such as neighbouring Italy, which was severely affected and blocked by the virus. This crisis showed the importance of local production and short food supply chains that were not affected by international

restrictions (Cappelli and Cini, 2020). In addition, it became necessary to realign the supply chains for fresh products in the short term, as many food service outlets closed (Richards and Rickard, 2020). As the virus spread to certain geographical areas, the behaviour of households under its influence changed significantly (Goddard, 2020). However, even during the pandemic, food remained a basic human need (Grashuis et al., 2020). In examining the behaviour of American consumers, Baker et al. (2020) found that consumption increased dramatically as households tried to store their supplies, with food purchases doubling between February 26th and March 11th, followed by a sharp drop in restaurant and retail sales, many of which closed. The crisis also prompted people to seek new ways to source their food, so online ordering and delivery of food and groceries skyrocketed (IPES-Food, 2020). With most countries in the world under lockdown (or in similar situations), almost all food was consumed in the household (Petetin, 2020).

On 19 March 2020, the Civil Protection Headquarters of the Republic of Croatia adopted a decision on measures that restricted social gatherings, work in trade, service activities, and the holding of sports and cultural events (Official Gazette, 2020a), along with a temporary ban on crossing the border with the Republic of Croatia (Official Gazette, 2020b). Due to the closure of markets that were estimated to be the focus of infection, about 10000 family businesses ran into difficulties selling their products. Many turned to direct sales, advertising sales, and delivery via internet portals and social networks, primarily Facebook, which was the most popular social platform in Croatia (Statista, 2020), and thus, digital markets became popular. Domestic products, fruit, vegetables, meat, eggs, and dairy products were delivered to many consumers on their doorstep. Under the new conditions in which most people worked from home, many citizens had the opportunity to cook daily. Catering facilities also closed, and restaurants were allowed to prepare and deliver food only in strict compliance with epidemiological instructions; only a few chose to conduct such business.

The global trends also confirmed that by far the largest increase in consumer expenditure on groceries was experienced by online retailers (Grashuis et al., 2020). Although many consumers had previously resisted online grocery shopping because they liked to personally check the quality and freshness of meat and vegetables, online grocery shopping suddenly became very sustainable because of lockdowns and staying at home (Deloitte, 2020).

In addition to the global increase in demand for e-commerce and food delivery services from producers, the practice of shopping in supermarkets changed significantly as visits became less frequent (Goddard, 2020), and many households bought processed, packaged, and frozen food to secure mid-term supply of food (Boons et al., 2020; Cranfield, 2020). Lockdowns aimed at limiting the spread of COVID-19 and changes in customer behaviour revealed weaknesses in existing supply systems. Customers responded to the spread of the virus by creating stocks that led to empty shelves (Goddard, 2020) and rising food prices both locally and globally, as well as problems in regular distribution (Benton, 2020).

As Grasso (2020) pointed out, panic buying was a common human response to crisis, which was not caused by food shortage per se, but rather by the fear of scarcity. Other research also confirmed the role of fear and anxiety associated with the new virus and their impact on changing the behaviour of individuals (Harper et al., 2020). When individuals perceived a loss of control over their environment, we posited that they preferred to acquire utilitarian products in order to reinstate their sense of control (Chen et al., 2017), which in the case of the coronavirus crisis largely referred to the purchase of food because the human attitude towards food was not rational (Grasso, 2020). Only in the UK, panic buying resulted in an increase of £1bn worth of food (Nicola et al., 2020). Consequently, the accumulation of stocks led to significant amounts of food waste (Grasso, 2020).

Changes also occurred in food consumption at the household level. Results of a study conducted in Italy indicated that Covid-19 and the subsequent lockdown induced about half the respondents to eat more food (Scarmozzino and Visioli, 2020). Exploring changes in the nutrition and physical activity of respondents in Europe, Africa, Asia, and North and South America at the time of lockdown, Ammar et al. (2020) confirmed that most respondents excessively consumed unhealthy food. Di Renzo et al. (2020) came to similar results when researching consumption, noting more snacking between meals and an overall higher number of main meals, as well as a higher impact of physical distancing and self-isolation on the daily lives of Italian citizens. They noticed that consumers' increased diet, in addition to boredom caused by interruption of work routines and lack of activity outside the home, was affected by constant listening to or reading news about COVID-19, which increased stress and often led to the consumption of "comfort food" rich in sugar. Naja and Hamadeh (2020) also reported the impact of fear and anxiety on changes in dietary patterns during the outbreak of COVID-19. The results of research in China during the initial phase of the COVID-19 outbreak revealed that half of the respondents experienced a significant impact of the pandemic on their psychological state, and approximately one third reported moderate-to-severe stress, anxiety, and even depression (Wang et al., 2020). Until that time, studies on food management during the COVID-19 lockdown and consequently its impact on the generation of food waste focused on different countries, like Tunisia, UK, United States, Italy, and Australia (Jribi et al., 2020; WRAP, 2020; Babbitt et al., 2021; Principato et al., 2022; Ananda et al., 2023). Given all the above aspects of the COVID-19 pandemic and their impact on everyday life, the aim of this research was to investigate changes in several aspects of food safety, like patterns of food behaviour among Croatian consumers, in order to recognize the immediate impact of isolation and lockdown on food purchase, handling, storage, preparation, and consumption, and consequently the impact on the generation of food waste at the household level. Attitudes and behaviours associated with food waste were also examined, as well as awareness of the problem of food waste at the time of the COVID-19 pandemic, exploring the role of socio-demographic factors in the households of the respondents.

## **Materials and methods**

Questionnaires are often used in household food waste surveys to measure consumers' perceptions of their own estimation of the amount of food they throw away (Visschers et al., 2016) or to investigate the root causes of food waste (Koivupuro et al., 2012).

For the purposes of this research, a structured questionnaire was designed and created online using Google form software (Google Forms, Google Inc.). Data were collected in the period from April 28 to May 10 2020, during the lockdown in Croatia. In the questionnaire, respondents were asked to self-estimate the percentage of food they threw away, considering the food purchased before and during the lockdown. The survey questionnaire was developed in Croatian language and distributed via e-mail, Website of the Centre for the Prevention of Food Waste – FWAPC, and social networks. The link was sent to potential respondents who were asked to pass it on to their friends and acquaintances. The survey questionnaire was filled out by 1024 consumers from all over Croatia, who had, before fulfilment, declared that they were fully or largely responsible for the handling of food in their household, which included the purchase and preparation of food in the household. The sample was convenience.

The questionnaire included a total of 26 questions divided into three groups: food purchasing (10 questions), food preparation (10 questions) and wasting food (6 questions). These sections drew on available relevant literature on food waste and included: situational, psychological and social factors, food supply habits, purchasing behaviours and food management before and during lockdown. In

addition, the following socio-demographic data were collected by the questionnaire: gender, age and the level of education of the respondents, the number of household members, the number of children under the age of 18, household income, residential unit and dwelling.

To measure the constructs, statements were used for which the respondents rated their degree of agreement on a 5-point Likert scale, where the following values were defined: 1 - I do not agree at all, 2 - I mostly disagree, 3 - I cannot decide, 4 - I mostly agree and 5 - I totally agree. Only for the last question, about the amount of food that the respondents themselves estimated, were seven possible answers offered. For statistical calculations, SPSS (version 25, IBM, Armonk, NY, USA) was employed to perform descriptive and inferential statistical analysis. For the SEM analysis, Onyx, version 1.0-872, a software specifically designed for structural equation modelling used. As stated in the introduction, earlier studies found out that shopping habits, storage, preparation and consumption of food affected the generation of food waste at the consumer level and these categories were represented in this study, along with socio-demographic characteristics of households. When processing data, to check multicollinearity, Spearman rank correlation coefficients were calculated between statements with reference to psychological constructs and socio-demographic characteristics.

## Results

Incomplete questionnaires were excluded from the analysis to ensure the validity and reliability of the results. Only fully completed questionnaires were included in the dataset. This approach was adopted to avoid potential biases or inaccuracies that might arise from missing data. After validating the data, it was found out that a large majority of the 1024 respondents who participated in the survey were female (76.95%), compared to male respondents (23.05%). According to the age distribution, the dominant age group with the highest proportion of respondents was 30-45 years (54.98%), while the lowest proportion was over 60 years (4.00%). Most respondents had a college or bachelor's degree (55.37%), and the lowest proportion of respondents had only completed elementary school (0.29%). Within the sample, the most frequent respondents were those with three household members (30.08%) and two household members (24.02%), and the least frequent were those from households with five or more members (4.79%). The highest number of households in the survey had no children under the age of 18 (50.59%) and the number of households with one (23.05%) and two children (18.16%) is almost equal. In contrast, the lowest proportion was found in households with more than three underage children (1.17%). Most respondents believed that their income was in the lower-middle range (43.85%) or in the upper-middle range (37.01%). The predominant residential unit in the survey was the apartment (62.01%) and urban dwelling (82.81%). Due to the non-probabilistic sampling design (convenience samples), the sample cannot be considered the representative of Croatia's territory. According to the respondents' education, the sample is not representative of the general population, representing more respondents with higher education. Besides, the household's income level covered by the survey was also above the national average. The data were collected based on the respondents' own assessment, not by the classification into well-defined groups according to the numerical value. Furthermore, respondents living in an apartment in the urban dwelling, middle and upper-income households with three or two members dominate the sample, and almost half of the surveyed households are without minor children. Another limitation of the studied sample is related to the sample structure, given that the dominant females are from the younger age groups. Moreover, the online survey method's choice is also limiting since online surveys are not available to certain groups of the population. Some respondents do not have the

appropriate technical equipment and skills to use them, such as people with a low level of education or older people and low-income households.

**Table 1.** Socio-demographic characteristics of the sample (N = 1024)

Characteristics of the respondents		N	%
Gender	Male	236	23.05
	Female	788	76.95
Age range	18-29	154	15.04
	30-45	563	54.98
	46-60	266	25.98
	60+	41	4.00
Education	Elementary school	3	0.29
	High school	277	27.05
	College/bachelor's degree	567	55.37
	Master's degree/ PhD	177	17.29
Number of household members	1	113	11.03
	2	246	24.02
	3	308	30.08
	4	196	19.14
	5	112	10.94
	More than 5	49	4.79
Number of children under 18 years in household	0	518	50.59
	1	236	23.05
	2	186	18.16
	3	72	7.03
	More than 3	12	1.17
Income per Household	Low	42	4.1
	Lower-middle	449	43.85
	Upper-middle	379	37.01
	High	154	15.04
Residential unit	Apartment	635	62.01
	House	389	37.99
Dwelling	Urban	848	82.81
	Rural	176	17.19

Table 2 shows the mean values of the statements related to food purchases. As can be seen, the answers in the group of statements concerning food purchases ranged from 1.88 to 2.70, with the respondents generally responding negatively, i.e., they did not agree with the statement, or they declared themselves neutral. In fact, the most neutral responses referred to the fear of shop closures that led them to buy more food than usual ( $2.78 \pm 1.45$ ). This can be interpreted as the fact that respondents were not entirely sure whether a stable food supply system existed during the lockdown. In addition, it was found that respondents did not have an excessive sense of control over the lockdown situation and bought more food than usual ( $2.70 \pm 1.54$ ). Contrary to the assumption, an even lower value of the respondents' answers ( $2.02 \pm 1.44$ ) showed that other people or the media generally did not influence on respondents in purchasing food items which they would not usually buy. However, excessive food purchases or regular orders of new food supplies, which created an excessive stock of food that they would not otherwise buy, led respondents to conclude that they had neither the knowledge nor the skills to manage the resulting food supply. The most negative answers were found in the question "I couldn't store all the food I bought properly because I didn't have enough space and therefore some of the food was thrown away." ( $1.88 \pm 1.46$ ). This shows that the respondents mostly bought carefully, for the sake of reasonable food consumption and reducing food waste to a minimum. On the other hand, they forgot previously purchased food ( $1.82 \pm 1.34$ , table 4) due to the excessive amounts of food purchased since the beginning of the pandemic. They could not store all purchased food properly, so some food was

thrown away, because it spoiled more quickly. Likewise, an almost neutral statement ( $2.70 \pm 1.54$ ) was found about the respondents' sense of control of the situation with excessive food purchases. Thus, it cannot be said that by buying more food, respondents had a sense of control in situation of reduction in the food supply, which is still contrary to a general opinion about reasons why people mostly rushed to shops and malls. The low value ( $2.16 \pm 1.56$ ) of food ordering statements shows us that respondents still relied on the food and prepared meals they bought themselves in their own households.

**Table 2.** Mean value of statements related to food purchases

Statement	Mean $\pm$ Std. Dev.
1. Out of fear of closing the stores, I bought a lot more food than usual.	2.78 $\pm$ 1.45
2. Under the influence of other people and / or the media, I bought groceries that I do not usually buy.	2.02 $\pm$ 1.44
3. By over-buying, I have created an excessive supply of food.	2.13 $\pm$ 1.47
4. I realized that I do not have the knowledge and skills to manage the produced food supply.	1.2 $\pm$ 1.42
5. I regularly ordered deliveries of new food not to feel a shortage of food.	2.17 $\pm$ 1.56
6. Purchasing food gives me a sense of control of the situation and comfort because I know that I am insured.	2.70 $\pm$ 1.54
7. I could not store all the food I bought adequately because I did not have enough space, so some of the groceries were thrown away.	1.88 $\pm$ 1.46
8. Since there was too much food stored in the refrigerator and insufficient air circulation, I have noticed that some of the food dried or spoiled faster.	2.10 $\pm$ 1.47
9. Some foods have expired, so I threw them away because I strongly believe in "best-before" and "use by" dates.	2.15 $\pm$ 1.53
10. The food bought or delivered was not of good quality and quickly fell into disrepair and was thrown away.	1.92 $\pm$ 1.40

As shown in Table 3, high correlations were found when measuring all statements concerning food purchases. All statements within the group on food purchases had a significant positive correlation, with the correlation varying between 0.5 and 0.7 ( $p < 0.001$ ). In particular, the first three statements within the group had a strong positive correlation. As expected, respondents who were influenced by other people and/or the media out of fear of shops closures and bought more groceries or those they would not normally buy believe that excessive shopping has led to an excessive food supply.

**Table 3.** Correlations of food purchase statements

	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	0.635**	0.640**	0.517**	0.499**	0.606**	0.545**	0.500**	0.410**	0.485**
2.		0.695**	0.657**	0.587**	0.586**	0.655**	0.535**	0.515**	0.568**
3.			0.707**	0.577**	0.558**	0.664**	0.574**	0.504**	0.591**
4.				0.575**	0.541**	0.742**	0.665**	0.630**	0.604**
5.					0.632**	0.592**	0.542**	0.509**	0.617**
6.						0.567**	0.555**	0.472**	0.519**
7.							0.736**	0.640**	0.702**
8.								0.605**	0.658**
9.									0.633**

1. Out of fear of closing the stores, I bought a lot more food than usual. 2. Under the influence of other people and / or the media, I bought groceries that I do not usually buy. 3. By over-buying, I have created an excessive supply of food. 4. I realized that I do not have the knowledge and skills to manage the produced food supply. 5. I regularly ordered deliveries of new food not to feel a shortage of food. 6. Purchasing food gives me a sense of control of the situation and comfort because I know that I am insured. 7. I could not store all the food I bought adequately, because I did not have enough space, so some of the groceries were thrown away. 8. Since there was too much food stored in the refrigerator and insufficient air circulation, I have noticed that some of the food dried or spoiled faster. 9. Some foods have expired, so I threw them away because I strongly believe in "best-before" and "use by" dates. 10. The food bought or delivered was not of good quality and quickly fell into disrepair and was thrown away.

\*\* Statistically significant at level  $p < 0.001$



The strongest correlation was found between statements that measure the ability to manage food supply using food storage methods, at 0.742 ( $p < 0.001$ ), and a statement that measured the amount of food associated with larger purchases, at 0.707 ( $p < 0.001$ ). In general, all statements questioned showed a correlation between increased food purchases and a feeling of safety. There is an interesting correlation between ordering and buying food, which was high, at 0.632 ( $p < 0.001$ ).

Table 4 shows the mean values of the statements regarding the storage and preparation of food. A revision of the table shows that the respondents made a great effort to use fresh and perishable food first ( $4.49 \pm 0.84$ ) and that they did not forget about food purchased before the pandemic ( $1.82 \pm 1.34$ ). Furthermore, they tried to cook almost every day ( $4.54 \pm 0.85$ ) and tried not to overdo it in meals, although this value was very close to a neutral value ( $2.60 \pm 1.51$ ). Leftovers were mostly consumed in the next meal ( $4.33 \pm 0.96$ ) or frozen for later ( $3.41 \pm 1.58$ ), and they tried to use up all the supplies purchased before the pandemic ( $3.47 \pm 1.44$ ). In comparison, due to trying new recipes, they did not throw more food in lockdown than usual when cooking according to tried recipes ( $1.83 \pm 1.33$ ).

**Table 4.** Mean values of statements related to the storage and preparation of food

Statement	Mean $\pm$ Std. Dev.
1. I try to use fresh and perishable foods first, and only than those that last longer.	4.49 $\pm$ 0.84
2. Due to excessive amounts of purchased food, previously purchased groceries have been forgotten since the beginning of the pandemic.	1.82 $\pm$ 1.34
3. Given the more time I spend at home, I try to cook every day while using the groceries I already have in the household.	4.54 $\pm$ 0.85
4. When preparing food during the lockdown, I exaggerated the number of meals.	2.60 $\pm$ 1.51
5. I consumed leftover meals in the next meal or the next day.	4.33 $\pm$ 0.96
6. I froze the leftovers to keep them preserved for the subsequent period.	3.41 $\pm$ 1.58
7. The lockdown served me as an excellent opportunity to spend all the supplies I had before.	3.47 $\pm$ 1.44
8. Due to trying new recipes during the lockdown, I sometimes throw more food than usual when cooking according to tried recipes.	1.83 $\pm$ 1.33

Table 5 shows the correlations between food storage and preparation, and those statements had lower correlation values.

**Table 5.** Correlations of food storage and preparation statements

	2.	3.	4.	5.	6.	7.	8.
1.	NS	0.316**	NS	0.260**	0.157**	0.168**	NS
2.		NS	0.485**	NS	0.198**	0.208**	0.602**
3.			NS	0.207**	0.203**	0.247**	NS
4.				0.119*	0.158**	0.292**	0.483**
5.					0.343**	0.212**	NS
6.						0.404**	0.230**
7.							0.297**

\*\* Statistically significant at level  $p < 0.001$ , NS – not significant

1. I try to use fresh and perishable foods first, and only than those that last longer. 2. Due to excessive amounts of purchased food, previously purchased groceries have been forgotten since the beginning of the pandemic. 3. Given the more time I spend at home, I try to cook every day while using the groceries I already have in the household. 4. When preparing food during the lockdown, I exaggerated the number of meals. 5. I consumed leftover meals in the next meal or the next day. 6. I froze the leftovers to keep them preserved for the subsequent period. 7. The lockdown served me as an excellent opportunity to spend all the supplies I had before. 8. Due to trying new recipes during the lockdown, I sometimes throw more food than usual when cooking according to tried recipes.

The highest value was found for the correlation between exaggeration in the preparation and consumption of purchased food before the outbreak of the pandemic, with only 0.485 ( $p < 0.001$ ). There

is a logical discrepancy between statements about the first-time use of fresh and perishable food and the use of food purchased before the pandemic, as well as the increased waste of food through trying out new recipes. The only statement related to all the constructs studied regarding the throwing and preparation of food was the statement that the lockdown gave respondents an excellent opportunity to consume all the food supplies they had before. But even in this case, the correlation was low, ranging from 0.168 to 0.404 at  $p < 0.001$ . Given the correlation's strength, it can be concluded that respondents who sometimes threw more food in the lockdown due to trying out new recipes also forgot previously purchased food. They also exaggerated the number of meals during the lockdown because excessive amounts of food have been purchased since the pandemic. Analysis of a group of food preparation statements reveals that respondents try to use fresh and perishable foods first, and then those that last longer. Moreover, given the more time they spend at home, they try to cook every day and use their already stored foods. These two statements recorded the highest point of agreement within the group regarding food preparation behaviour. In contrast, respondents least agreed with the statements that due to excessive amounts of food purchased since the beginning of the pandemic, previously purchased food was forgotten or that more food was thrown away due to trying new recipes in lockdown.

Table 6 shows the mean values of statements about wasting food. As for the meals that got thrown away, most respondents felt very bad ( $4.69 \pm 0.65$ ). They felt that all food should be used, especially in times of uncertainty caused by the lockdown, but still not to the extent that they would eat all surplus food and gain weight ( $2.74 \pm 1.38$ ). They threw the food away only if it was spoiled, for the fear of their health ( $4.44 \pm 0.97$ ). Respondents who wasted expired food, because they firmly believed in "best-before" and "use by" dates, also wasted food when food was not of a good quality and spoiled quickly. Respondents who ate much more than usual at the time of lockdown to prevent food from being wasted, as expected, exaggerated the number of meals when preparing food during the lockdown.

**Table 6.** Mean values statements about food waste

Statement	Mean $\pm$ Std. Dev.
1. I feel terrible when wasting food, and I am trying not to waste food at all.	4.69 $\pm$ 0.65
2. Wasting food at this time of uncertainty is not justified, and all food should be used.	4.61 $\pm$ 0.76
3. In times of lockdown, I ate a lot more than usual, just to keep food from being wasted.	2.50 $\pm$ 1.50
4. I find it better to waste excess food than to overeat and gain weight.	2.74 $\pm$ 1.38
5. I waste food only if it spoiled to fear of health.	4.44 $\pm$ 0.97
6. Food waste in my household is mostly the result of other household members' behaviour and not me personally.	3.03 $\pm$ 1.47
7. I am afraid of the possibility of food shortages in the near future, so I started to planned food management.	3.04 $\pm$ 1.49

However, some respondents believed that it is much better to throw away excess food than to overeat and gain weight, and they also admitted that they wasted spoiled food out of fear for their health. They also believed that food waste in their household resulted from the behaviour of other household members and them personally, and that they were not afraid of the possibility of food shortages in the near future. Most of the respondents stated that they wasted less than 10% of food during the lockdown than they usually waste, which is in line with the obtained values of other statements regarding food waste. Most respondents tended not to waste food and also took steps to prevent that from happening. They wasted the food only if it was spoiled, due to fear for their health. Table 7 shows that the highest correlation was found in the statements concerning the respondents' negative subjective feeling when wasting food and opinions that all food should be used in times of uncertainty (0.508  $p < 0.001$ ).

However, it is interesting that there is no correlation between the statements that it is better to waste excess food than to gain weight and the statements about the bad feeling that results from wasting the food. It can be determined that good planning is more important than consuming all the food in a meal. Also, other household members' behaviour, i.e., food waste as a consequence of others' behaviour in households, is in a very high correlation with the fact that the respondents ate more just not to throw anything away ( $0.412\ p < 0.001$ ). Other correlations associated with food waste are either low or non-existent.

**Table 7.** Correlations of food waste statements

	2.	3.	4.	5.	6.	7.
1.	0.508**	NS	-0.217**	0.264**	NS	0.156**
2.		NS	-0.138*	0.220**	NS	0.211**
3.			-0.161**	0.137*	0.412**	0.368**
4.				-0.128*	-0.109*	-0.240**
5.					0.209**	0.236**
6.						0.383**

1. I feel terrible when wasting food, and I am trying not to waste food at all. 2. Wasting food at this time of uncertainty is not justified, and all food should be used. 3. In times of lockdown, I ate a lot more than usual, just to keep food from being wasted. 4. I find it better to waste excess food than to overeat and gain weight. 5. I waste food only if it spoiled to fear of health. 6. Food waste in my household is mostly the result of other household members' behaviour and not me personally. 7. I am afraid of the possibility of food shortages in the near future, so I started to planned food management.

## Discussion

The findings of this study agree with the findings of studies in other countries (Jribi et al., 2020; WRAP, 2020; Babbitt et al, 2021; Principato et al., 2022; Ananda et al., 2023). The research above, including this study, found out that the pandemic drastically changed household purchasing patterns and their food management during COVID-19 lockdown. More careful planning and better utilization of food in the household produced the reduction in food waste. Research conducted during the COVID-19 lockdown in the United Kingdom (WRAP, 2020) also confirms that purchase patterns changed. The frequency of purchases decreased significantly, while the amount of food purchased increased. Citizens' response to lockdown included more pre-purchase planning (supply checking and inventory making), better home storage (refrigerator and freezer management, more freezing), and creative approaches to cooking and using the leftovers. Tunisian consumers also paid more attention to food management during lockdown (Jribi et al., 2020). Respondents overwhelmingly stated that they were trying to control their food waste level, probably under the influence of its lower availability due to new circumstances, and they bought food thinking about how it would be used. Also, during the COVID-19 crisis, respondents' awareness of the problem of food waste increased. Findings from Australia revealed that households reduced their food waste by 9% compared to pre-COVID-19 level (Ananda et al., 2023). Respondents in that study showed improvements in desirable positive food management behaviours, such as more frequent use of grocery lists, meal planning, better use of storage, and effective food preparation and storage skills during the pandemic. Furthermore, Italian households dramatically changed their eating habits and behaviour during the COVID-19 lockdown resulting in a significant reduction in food waste (Principato et al., 2022). In doing so, the spread of planning-related food management practices (compiling shopping lists, planning food purchases, and preparing meals in advance, reusing leftovers for other recipes) played a key role in reducing food waste. Principato et al. (2022) confirmed the finding of an earlier study according to which consumers, after a panicky purchase during the first few days of lockdown,

tended to plan more carefully for future food and meal purchases due to logistical difficulties in purchasing. An exception to these results is a study conducted in Spain that estimated an increase in household food waste during COVID-19 lockdown (Aldaco et al., 2020). However, these estimates are based on secondary data and not on direct measurement or reporting by households. Current study did not find a mutually significant correlation between socio-demographic factors other than the expected positive correlation of household members with the number of minor children in the household (0.51). There was also no significant correlation between socio-demographic factors and behaviour when buying, preparing, and throwing food, as shown from the presentation of correlation coefficients. In contrast to the results obtained by this study, other researchers found a significant impact of socio-demographic factors on reducing food waste. In a survey of Italian consumers, Principato et al. (2022) found that young people significantly reduced their food waste. They noticed that their otherwise wasteful behaviour with food was corrected during the lockdown because they had to spend more time cooking and managing meals. The same research revealed the important role of place of residence in reducing food waste during the lockdown, i.e., the urban/rural difference as well as the size of the cities in which the respondents live. Furthermore, the study by Jribi et al. (2020) found that the intention to avoid food waste increases significantly with the respondents' age and level of education. Likewise, women, people over the age of 40, and college-educated consumers typically prevent food waste disposal by freezing, donating, or recycling. At the same time, male respondents and those less educated wasting more food. However, the research did not find significant links between socio-demography and behaviour when purchasing food.

"This study has some strengths and limitations that should be acknowledged. The strength of our research lies in the fact that we conducted the research during the strongest period of the Covid-19 epidemic, after the announcement of the lockdown. The main limitation stems from methodological reasons, namely the self-reported questionnaire, which may lead to actual data misreporting. This particularly refers to the tendency of respondents to present themselves as better when it comes to so-called "green" behaviours and habits."

## Conclusions

This research aimed to answer the question: Has COVID-19 lockdown changed consumers' behaviour with food and food waste? Based on the results of an online survey of 1024 Croatian consumers about their behaviour when buying, preparing, and wasting food during isolation and lockdown, we concluded that COVID-19 lockdown had a positive effect on the behaviour of households when handling food and that the amount of food waste was reduced during lockdown.

As a result of changing behavioural patterns, which are influenced by physical distance measures such as staying and working from home, but also by more time and opportunities to prepare meals in the household, consumers could adjust their food behaviour and plan meals better, combined with generally better food management in the household (preparation of perishable food, then non-perishable food, consumption of previously piled up groceries, and usage of meal residues/leftovers). The role of the psychological consequences of crises on food behaviour, which was shown to affect both purchasing and consumption, should not be neglected. Respondents indicated that they bought more but also ate larger amounts of food during the lockdown, which may be a consequence of fear of a virus and an uncertain future, or boredom due to staying at home. For some respondents, it is possible that they found themselves in a situation of loss of income, which was the economic context of the crisis caused

by the COVID-19 pandemic. All of the above resulted in the respondents' tendency to manage food more rationally in the household and throw away less food than usual.

This research contributes to a better understanding of how crisis situations affected consumer eating habits and food waste awareness. It can be a starting point for the quantitative measurement of the actual amount of food waste generated at the household level, as the pandemic COVID-19 is ongoing, and the possibility of a new lockdown is not excluded. It is necessary to increase information spreading on the importance of avoiding and preventing food waste to maintain the trend of reduction of food waste at the household level as well as to maintain motivation for positive consumer behaviour in planning the purchase, consumption, and proper storage of food. This can be done through campaigns to raise awareness about food waste from environmental protection and resource efficiency perspective, especially in light of the emerging global crisis that modern humanity does not remember.

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