

ORIGINAL ARTICLE

COVID-19 lockdown impact on Tunisian consumer behaviors and awareness related to food consumption and wastage during celebrations: Case of study “Ramadan month”

Hanen Ben Ismail ^{1,2},  Sarra Jribi ^{1*},  Darine Doggui ³,  Hajer Debbabi ¹ 

¹ Department of Agri-Food Industries, National Institute of Agronomy of Tunisia (INAT), UR17AGR01, University of Carthage, Tunis, Tunisia
² Faculty of Mathematical, Physical and Natural Sciences of Tunis, LR11ES09, University Tunis El Manar, Tunis, Tunisia
³ National Institute for Consumption (INC), Tunis, Tunisia

Abstract

Background: The COVID-19 pandemic deeply marked 2020 at different scales: socially, economically, and environmentally. Accordingly, several changes were observed at these different scales. **Aims:** This study aimed to highlight changes induced by COVID-19 lockdown on consumer behaviors and awareness related to food consumption and wastage during a celebration period, Ramadan in Tunisia. **Methodology:** An online survey on 317 respondents (71.6% women and 28.4% men) was carried out during the first 15 days of Ramadan season and was focused on demographic data, awareness and attitudes toward food waste, food purchase and consumption habits. **Results:** Although the COVID-19 has impaired the construction of Iftar menus, 53.9% of respondents have kept preparing, overcooking and consuming traditional meals. Interestingly about 66% claimed decreasing food waste this year. **Conclusion:** Results of this study have clearly established that time of crisis has led to virtuous consumers' behaviors and attitudes, in place of consumerist practices, during Ramadan celebration season.

Keywords: COVID-19 Lockdown, Ramadan, consumer's behavior, leftover, food waste.

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1 Introduction

The COVID-19 pandemic due to a novel Corona-virus SARS-CoV-2 emerged in December, 31, 2019 in the city of Wuhan, in the Chinese province of Hubei and has rapidly spread to other countries to become a pandemic. Until this manuscript preparation, World Health Organization (WHO) Corona virus Disease dashboard showed more than 392,612,632 confirmed cases and deaths exceeded 5,747,504 worldwide ¹. Fortunately, as of 2nd February 2022, 52.6% of whole world population was completely vaccinated ¹. All over the world, social distancing, community and restriction measures, such as lockdown, have been implemented in order to slow the virus spread before availability of the vaccine. These measures induced changes in consumers' life and consumption habits ². Consumers' behavior can be influenced by several factors such as culture, seasonality, the price of the products. For example, during common holiday season such as Christmas, Hanukkah or Ramadan, consumption behaviors have shifted from a religious ritual to a holiday marked by overconsumption, especially by the purchase of foodstuffs, apparel and leisure activities ^{3,4}. According to a previous survey ⁵, in some Arabic countries (United Arab Emirates, Saudi Arabia, and Egypt), 53% of respondents increased their spending during Ramadan, especially on food and groceries.

On 2020, Ramadan a ritual celebrated annually by 1 575 000 000 Muslims all over the world, began on April 24th, 2020 which coincides with the COVID-19 lockdown. Muslims fast during Ramadan, to commemorate the revelation of the Quran ⁶. It

consists on abstaining from eating, drinking, taking medications or drugs, smoking and having sex between sunrise and sunset. Fasting takes place in the daylight hours, between 13 and 18 h depending on the geographical location and season. Food intake is exclusively nocturnal and occurs during “*Iftar*”, eaten after sunset, and “*Suhur*”, the meal eaten just before sunrise ⁷. Although Ramadan is a time dedicated to fasting and to controlling desire, cooking and tableware, festive and gourmet evenings have become the pillars of this month.

Food waste is a global issue, because of its environmental, social and economic impacts ⁸. Household food waste is around 30 % of total food waste ⁹. In Near East and North Africa region, it has been estimated around 34% at the consumption stage which corresponds to 250 Kg per year per individual ⁸. Changes in consumers' attitudes toward food wastage were observed according to periods especially, during Ramadan. In Maghreb and Middle East countries as significant increase in household food waste during this period when compared to other months ^{10, 11}. In Middle-East, a range of 25% - 40% of the prepared food were thrown away during Ramadan ^{12, 13}. In North Africa, despite awareness toward food wastage, observed through ¹¹ survey, authors observed higher self-reported food wastage during Ramadan, particularly fruits, vegetables, cereals and bakery products. Similarly, according the Tunisian National Consumer Institute (INC) ¹⁴, the main wasted food products are: cooked meals (66.6%), bread (46.0%) and fruit (31.7%).

The increase in food wastage during Ramadan was probably related to food preparation and eating habits changes ¹¹. Like

Christmas or Hanukkah, the menus prepared during Ramadan are different quantitatively and qualitatively from that usually consumed during the rest of the year ¹⁵. These behaviors are in contrast with basic principles of Islam for which Muslims are asked to share excess food with the poor. According to Sandikci and Omeraki ³, a common holiday season theme is consumption.

The COVID-19 virus and the measures taken to slow its spread (i.e. lockdown) have impacted positively consumer awareness, attitudes and behaviors related to food wastage in Tunisia ¹⁶. Previous results of Jribi *et al.* ¹⁶ and van Geffen *et al.* ¹⁷ highlighted that, food waste reduction, during COVID-19 crisis, could be more associated to direct personal benefits than to pro-environmental concern. Therefore, it would be interesting to consider how the COVID-19 lockdown would affect consumers' behavior during celebrations moments.

This study aimed to evaluate household food wastage management, within the context of celebration during pandemic crisis. An on-line survey was conducted aiming to highlight the impact of COVID-19 outbreak lockdown on Tunisian consumer's attitudes, behaviors and motivations toward food consumption and wastage during Ramadan season.

2 Material and Methods

The study was based on an online survey in Tunisia using a structured questionnaire, adapted from previous studies performed in the North African region ^{11,18}.

2.1 Data collection and analysis

Data was collected using an online self-administrated survey in French language. This choice was made because of the increase on internet use during COVID-19 lockdown as well as security measures. The questionnaire was available on Google website (<https://www.google.com>) from April, 27 until May, 4, 2020, during COVID-19 outbreak lockdown (started from March, 20, 2020, in Tunisia) and Ramadan (started from April, 24, 2020). It was disseminated through institutional website, social media and mailing. Participation on the survey was voluntary and responses were anonymous.

The questionnaire consisted of 22 one option and multiple-choice questions divided into 3 sections: (1) Food purchase behavior and meal preparation (2) Extent of household food waste; and (3) Socio-demographic characteristics of respondents. All answers from participants not involved in the kitchen life were excluded from this study.

Data was primarily analyzed through Microsoft Excel software for counts and percentages. On a second step, Chi-square tests of independence were performed using GraphPad Prism (version 8, 2019), to test associations with demographic variables. Statistical significance was determined by $p < 0.05$.

3 Results

3.1 Socio demographics of respondents

As shown on Table 1, 71.6% of the respondents are women, 35.7% live in households with more than 4 members, 68.4 % were active professionally and 86.8% were highly educated. This was related to the recruitment mode on a voluntary basis, to the mode of administration through social media, as well as to the language used (French). Thus, the sample cannot be considered as representative of the adult population in Tunisia. For this reason, survey weights were applied and used in all Chi-square analyses aiming to improve the panel's representativeness ¹⁹.

Table 1: Respondents profiles (n=317)

	Respondents (%)
Gender	
Women	71.6
Men	28.4
Age (years old)	
18 – 29	30.6
30– 44	38.8
41 – 59	25.9
60 and more	4.7
Number of persons in the household	
1	1.6
2	17
3	16.4
4	29.3
5	17.4
6 and more	18.2
Education	
Primary and high school	13.2
University	86.8
Occupation	
• Farmers	1.9
• Craftsmen, traders, entrepreneurs	2.5
• Managers and higher intellectual professions	40.4
• Intermediate professions	8.2
• Employees	15.1
• Workers	0.3
• Retired	3.2
• Students	20.2
• Other people without activity	8.2

3.2 Food Purchase behaviors and attitudes during COVID-19 lockdown and Ramadan

Our results on shopping behavior revealed that 82.6% of respondents have adapted their shopping to the COVID-19 lockdown during Ramadan, whereas 14.2% who maintained their usual habits (Table 2). When this crisis coincides with the Ramadan in which eating at home with the family is a ritual, our data clearly showed that consumers tended to adapt their shopping habits. In particular, 93.3% respondents aged 60 years old and more declared to adapt their Ramadan shopping habits

during the lockdown, compared to 73.2% of respondents under 30 (p=0.0008; Table 1).

To occupy their day, half respondents buy their Ramadan food groceries from local small retailers during the COVID-19 lockdown, particularly those aged 60 years old and more (60%) and those having university education(55.5%); whereas, 36.9% especially with school education (69%) and middle-aged buy from supermarkets (Table 2). These results are different from those obtained by Jribi *et al.* ¹⁶ carried out during the first stages of the COVID-19 lockdown. Online grocery shopping has increased by 114%, when compared to previous study ¹⁶. Same trend was observed by Ben Hassen *et al.* ²⁰ in Qatar during post-Ramadan period.

Ramadan food shopping was performed for a majority of the respondents once a week (50.2%). However, 31.2% affirmed to do it 2 - 3 times a week and only 6.9% every day. In contrast, Sassi *et al.* ¹⁸ reported that, in a normal situation, 34.5% of Tunisian respondents declared to do shopping every day. Our findings are in agreement to those of Jribi *et al.* ¹⁶ in the beginning of the COVID19-lockdown. Results indicated that women declared to shop for food more often than men (Table 3). Cockburn-Wootten *et al.* ²¹ have established that grocery shopping was traditionally woman's responsibility, whereas men would go weekly in order to "replenish the food cupboard". Furthermore, the respondent's shopping frequency was significantly decreased with respondent's age, because of the elderly sensitivity to the SARS-COV-2 infection, when compared to other age groups ²².

Table 2: Impact of COVID-19 lockdown on grocery shopping behaviours during Ramadan

Respondents (%)	ALL		Gender		Age (years)				Education	
			Women	Men	18 - 29	29- 44	44 – 59	60 and more	Schools	University
Changes in grocery shopping behavior										
Yes, adapted to the COVID-19 lockdown	82.6	81	86.7	73.2	88.5	82.9	93.3	85.7	82.1	
No, as usual	14.2	15.9	10	19.6	11.5	13.4	6.7	11.9	14.6	
No opinion	3.2	3.1	3.3	7.2	0	3.7	0	2.4	3.3	
Chi square (df)	1.150 (2)		22.86 (6)				0.6088 (2)			
P value	0.5628		0.0008*				0.7376			
Main grocery shopping location										
Small retailers	50.9	55.7	38.9	54.6	50	46.3	60	21.4	55.5	
Supermarkets	36.7	30.5	52.2	25.8	40.2	45.1	33.3	69	31.7	
Hard discount	1.6	1.8	1.1	1	2.6	1.2	0	0	1.8	
Home deliveries/on line shopping	4.4	4.4	4.4	3.1	4.9	4.9	6.7	6.7	4.7	
Traditional local markets (« Souk »)	1.9	2.2	1.1	6.2	0	0	0	0	2.2	
Local farmers and producers	4.5	5.4	2.3	9.3	2.3	2.5	0	2.9	4.1	
Chi Square	10.62 (5)		43.91 (15)				33.71 (5)			
P value	0.0594		0.0001*				<0.0001			
Grocery shopping frequency										
Daily	7	8	4.4	5.1	1.6	1.2	0	7.1	6.9	
2 - 3 times/week	31.3	30	34.4	39.2	27.9	25.6	40	16.7	33.6	
Once per week	50	46	60	34	54	62.2	53.3	69	47.1	
Once every 15 days	9.2	12.8	0	7.2	13.1	7.3	0	7.1	9.5	
Once a month	0.6	0.9	0	1	0	1.2	0	0	0.7	
Rarely	1.9	2.3	1.2	13.5	3.4	2.5	0	0	2.2	
Chi square	15.76 (5)		59.08 (15)				12.38 (5)			
P value	0.0076*		<0.0001*				0.0300*			
Preparing a shopping list										
Always	36.1	41.1	23.3	34	41.8	28	46.7	9.5	40.1	
Often	26.9	27.43	25.5	36.1	27	11.5	20	19	28.1	
Rarely	24.7	22.1	31.1	25.8	21.3	28	26.7	45.2	21.5	
Never	12.3	9.4	20.1	4.1	9.9	32.5	6.6	26.3	10.3	
Chi square (df)	10.84 (3)		59.91 (9)				37.17 (3)			
P value	0.0126*		<0.0001*				<0.0001*			
Consumption intention of all purchased food items										
Yes, all of them	61.4	63.7	55.5	62.9	63.9	61	33.3	50	63.1	
Probably all	36.4	34.5	41.1	35	33.6	36.5	66.7	50	34.3	
No	1.9	2.2	1.1	2.1	2.5	2.4	0	0	2.2	
No opinion	0.3	0	2.3	0	0	0.1	0	0	0.4	
Chi square (df)	3.529 (3)		33.99 (9)				7.543 (3)			
P value	0.3170		<0.0001*				0.0565			

Table 3: Main reasons of households' food waste during Ramadan

Respondents (%)	ALL	Gender		Age (years)				Education	
		Women	Men	18 - 29	29 - 44	45 - 59	60 and more	High school	University
No wastage	37.8	39.8	33.3	45.4	26.2	45.1	46.7	23.8	40.1
Molds on foods	3.2	5.7	1.1	1	9.8	1.2	0	0	5.1
Expired dates	1.2	0.9	2.2	2	0	0	13.3	0	1.4
Too long storage	18.0	20.3	12.2	21.6	22.1	7.3	20	0.2	20.4
Poor cooking skills	5.4	5.7	4.4	4.1	9	2.4	0	0	6.2
Strange/bad odor and/or taste	3.2	3.1	3.3	3.1	3.3	3.7	0	0.2	3.3
Poor storage conditions	0.9	0.9	1.1	0	0.8	2.4	0	0	1.1
Overbuying	1.3	1.3	1.1	1	0	1.6	6.7	0	1.4
Overcooking	29.3	22.3	41.3	21.8	28.8	36.3	13.3	75.8	21
Chi square		13,96 (8)		109,5 (24)				71,96 (8)	
P value		0,0827		<0,0001*				<0,0001*	

When asked about the prior preparation of a shopping list, respondents were shared: 36% did it always, 27.1% often, 24.6% rarely and 12.3% never did a shopping list (Table2). Significant associations were found between grocery planning and demographics (Table2). This was higher than the result found (29.2%) by Sassi *et al.* ¹⁸ in a normal situation.

Regarding intentional consumption of bought food items, most of respondents declared that they would consume all of them (61%) or probably all of them (36%). This was significantly associated with age (Table 2). This finding highlights the high level of awareness toward food waste, even in a celebration season. Ben Hassen *et al.* ²⁰ reported that 44.81% of their respondents waste less during Covid-19 outbreak.

3.3 Meal preparation and consumption during COVID-19 lockdown and Ramadan

In order to assess the consumers' food basket composition during the COVID-19 lockdown and Ramadan, respondents were asked about their bought quantities of selected food items. Figure1 indicated that most of food items were purchased in usual quantities.

The most products bought during Ramadan were fruits and vegetables (97.5%), pastas (traditional ones like "couscous" and "nwasser") (96.8%), eggs (96.5%), milk (96.2%), canned food (95%), chicken (94%), cheese and bread (88.3%). On the other hand, sweet products (soft drinks and sweets) were the least purchased. Based on the food classification adopted by Shadman *et al.* ²³, food categories bought by respondents were especially Mediterranean-like and Ramadan style foods.

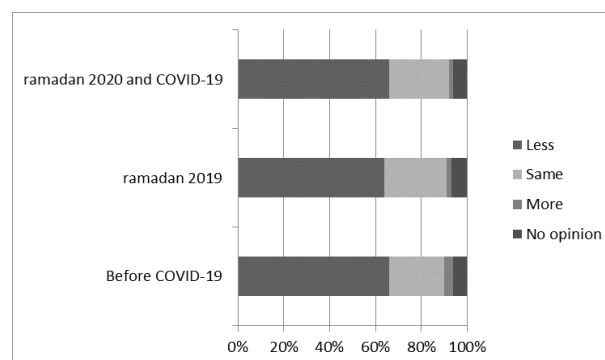


Figure 1: Self-assessment of household food waste, compared to the average Tunisian.

The majority of these products are known to be over consumed during Ramadan because they constitute necessary ingredients for many traditional Iftar recipes. *Suhur* is usually much lighter than Iftar. *Suhur* meal mainly consists of dairy products together with dates, bread and traditional dishes. In fact, the consumption from various food groups varied greatly during this month.

Results of this research also showed that the most stored food products were respectively mineral water (96.3%), canned food (67.8%), cheese and yogurts (45.11%), flour and semolina (33.4%), olive oil (30.9%), milk (28.7%), pastas (28%) and eggs (27%) (Figure1). All these stored items are usually consumed during Ramadan in traditional meals. Fortunately, other foodstuffs (bread, pasta, vegetables, fruits) and energy products were widely available ²⁴.

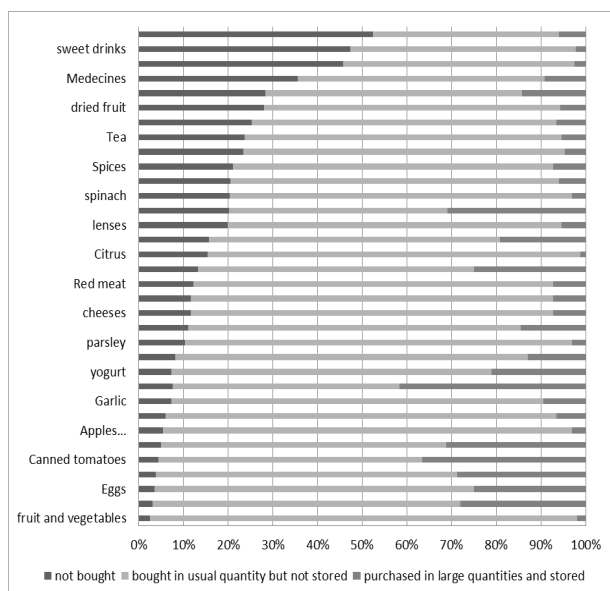


Figure 2: Self-reported ratio of food category bought during COVID-19 impacted Ramadan, expressed as the percentage of purchased food items.

Regarding the Iftar meal composition, our survey indicated that typical menus were always composed by soup (88.3%) salad (69.7%) and warm Tunisian entrees (“*brick*”, “*tajin*” or quiche) (49.8%), fruits (56.5%), coffee or tea (49.5%) and bread (60.0%) (Figure 2). In contrast, cereal based dishes (13%) and stews (25%) were not consumed on a daily basis. Usually a typical Ramadan Iftar menu varied, rich, generous and festive²⁵; it consists in soup, warm and cold entrees as well as at least two main course dishes. About the preparation itself, 54% respondents affirmed they cooked the Iftar traditional dishes as usual, and 18% of respondents declared probably while for 28% of respondents Covid-19 pandemic affected Ramadan habits. This is in accordance with a previous survey²⁴ demonstrating that 27% have reduced their food consumption (37% for the poorest households), in response to rising food prices during Ramadan and COVID-19 lockdown.

3.4 Levels and management of leftovers during COVID-19 lockdown and Ramadan

Respondents were asked about the levels of leftovers for each food group. Leftovers are mostly bread (68.1%), cooked cereal dishes (63.1%), stews (60.25%), soup (49.8%) and salad (39.4%) (Figure 4). The COVID-19 situation has not modified the common trend of over-cooking during Ramadan season. Like Christmas, special food is prepared and eaten in a family gathering at Ramadan²⁵. In this festive context, there is trend to excess portions prepared, if not eaten it leads to food waste²⁸.

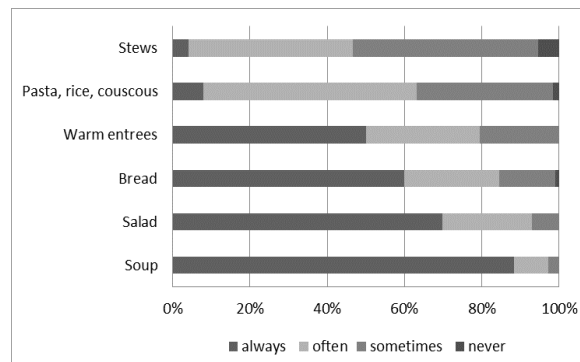


Figure 3: Self-reported ratio of meals categories consumed during COVID-19 impacted Ramadan, expressed as the percentage of prepared menus.

Regarding the leftover’s management, most of respondents (71%) claimed to eat them the next day. They also affirmed that leftovers were either frozen (6%), reused in another dish (4%), donated (3%), or feed animals (9%). Only 8% of respondents declared to throw them away. Our data are in contrast with studies conducted before COVID-19 pandemic, showing higher self-reported food waste in North Africa during Ramadan^{10, 11}. Baldwin¹² and Abiad and Meho¹³ have reported that around 25- 40% of the prepared food thrown away in Middle-East, during Ramadan. The most wasted food leftovers were salad (16%), cereal based dishes (13%) and stews (5%). In Tunisia, the main wasted food products during Ramadan were cooked meals (66.6%)¹⁴. In this survey, respondents unexpectedly declared to waste low amount of bread (4%), whereas in 2017, INC¹⁴ has reported high amounts of wasted bread (46.0%), as consumers prefer fresh bread rather than yesterday’s bread, in particular during Ramadan season.

Most of the respondents declared to eat the following days the remaining dishes, such as soup (90%), warm entrees (85%), salad (73%), and main courses (cereal based 59%; stews 58%). Leftovers of stews (13%), bread (9%) and cereal dishes (8%) were also stored in a freezer. These data are different than those of Jribi *et al.*¹⁶ during the initial stages of COVID-19 lockdown, indicating that 54% respondents declared to eat leftovers the next day.

Results showed that main courses (6%) including stews and cereal based meals and bread (6%) were donated by respondents. Gifting cooked food to others is a common cultural and religious practice in the Muslim world, in particular during Ramadan season. Redistributing leftovers is about identity and social relationships^{27, 28}. It also corresponds to the main motivations given by respondents in this study (Table 3).

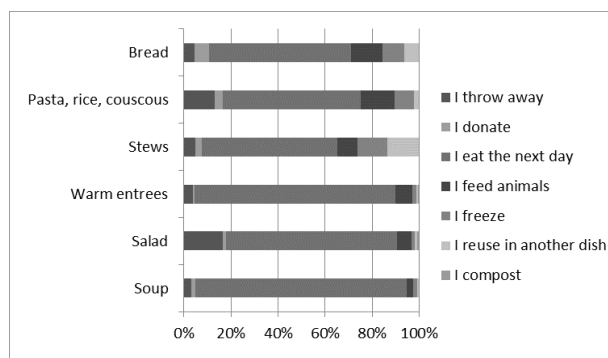


Figure 4: Managing leftover food categories during Ramadan 2020, expressed as the percentage of total remaining food.

Feeding animals with leftovers is a common practice in Tunisia, mainly with cereal based dishes (15%), stews (8%), warm entrees (7%) and even bread (13%). People may believe that food items or leftovers fed to pets or composted, not as waste ¹⁹.

In order to gain deeper insights about domestic food waste, respondents were asked to indicate the main reasons of food waste in their households, during Ramadan (Table3). About 37% of respondents declared not wasting food. This is probably related to general context as over 50% of Tunisian families were economically affected by COVID-19 pandemic ²⁹. Overcooking (29.8%) and long storage in the fridge (18.0%) were the main cited reasons for food waste. Overbuying, overcooking, and inappropriate food storage techniques were previously reported as significant drivers of household food waste ^{11, 30}. Overcooking might be related to Ramadan season, mainly, festivity and hospitality ^{25, 31} while there was less gathering. The storage period issue was related to a food safety concern. This was in accordance with findings of previous studies ^{18, 19, 32}.

4 Discussion

This research investigated household food wastage management, within the context of celebration during pandemic crisis. Food purchase is important for understanding the risk of food waste in households ³³. Ramadan is normally a peak period for food and grocery retailers. In that sense, the Tunisian National Institute of Statistics ²⁴ in collaboration with the World Bank has launched a survey to study and monitor the impact of COVID-19 on the daily life of Tunisians (1030 households) during the first two weeks of Ramadan, corresponding to the same period of our investigation. Nearly two-thirds of households in Tunisia have been impacted in one form or another by the COVID-19 pandemic, mainly through price increases. Respondents over 60 years were those who adapted the most their shopping habits to the situation. In fact, people over 65 were at risk for poor outcomes and higher mortality following infection with SARS-COV-2 ²². They had therefore to limit dramatically their

movements and consequently to change their daily habits. However, the self-declared change in the habits during the COVID-19 pandemic during Ramadan was not significantly associated to gender or education's level.

Small retailers attracted more respondents in this research. With a delay, small retailers have taken active measures to keep customers and staff safe like malls. Therefore, consumers have switched to local small retailers because of their proximity and food availability. Consumers preferred to buy from small traders as they can find traditional products there, particularly used throughout this season. Interestingly, our findings indicated that the lockdown allowed the development of new trends for Ramadan groceries, by bolstering online food delivery, including local food systems. In the COVID-19 context, online grocery shopping provides several advantages such time savings, home delivery and social distancing. The COVID-19 has also boosted demand for local food products (4.4% of respondents). Farmers around Tunis (capital of Tunisia) have taken this new opportunity, by opening e-commerce channels mainly through social media (Facebook, Instagram) and by adopting a direct-to-consumer distribution system for local and seasonal foods. We expect that these new trends would probably outlast this crisis.

Regarding Ramadan food shopping our results suggested that frequency for grocery shopping was affected more by the lockdown than by Ramadan season itself, since shopping was particularly challenging for consumers with the restrictions in place. People were only allowed to leave their homes for emergency or essential errands. Moreover, there was an increase in using shopping list. This might be related not only to lockdown restrictions, but also to the difficult economical context ^{34, 35}. Thomas and Garland ³⁶ have established that written shopping lists significantly decreased average expenditure. Furthermore, previous studies showed that planning food shopping with a shopping list contributes to lowering the amount of food wasted at the household level ^{37, 38}. In fact such practice may avoid oversupply ¹⁶. Indeed, food over-provisioning during shopping can increase directly food waste amounts ³⁹. Actually, some mobile phone applications can help consumers to manage household food inputs by for instance, developing a food inventory, meal plans, and shopping lists ²⁷. Altogether, findings clearly indicate that the COVID-19 lockdown impacted Ramadan habits, respondents have changed their shopping behaviors and attitudes not only by being more careful in buying food products such as preparing a shopping list and going to the grocery once a week, but also by avoiding over-buying food and reducing overstocking ⁴⁰. Lockdown restrictions, as well as the critical economic situation can probably explain this willingness to avoid discarding food items.

Consumption reached its peak in all Arab-Muslim countries during the month supposed to be that of restraint. Tunisian market was destabilized by COVID-19 crisis, which induced a

return to inflation (6.2%) over the month of April. This crisis had an effect on the production and movement of food. The increased consumption of vegetables led to a significant increase in prices since the start of COVID-19 lockdown. In fact, the price of fruits has increased sharply, nearly 14%²⁴. Meat, manufactured goods, hygiene and cleaning products would all have risen to around 10% of their price a month before²⁴. Consequently, as indicated by results, a modification of Iftar menu during the COVID-19 lockdown. By necessity or by choice, Iftar meals were simpler and less diverse in a COVID-19 context, than usual. This was related not only to the difficult socio-economic context³¹, but also to the fact that lockdown restrictions have limited guests and family gatherings. Our findings show that the COVID-19 pandemic has not impacted the consumers' food basket composition, typical of Ramadan season. Furthermore, consumers have avoided overstocking food items. Consumers tended to find the right balance between traditions and the particular COVID-19 context.

Although consumers still keep overcooking during Ramadan, our findings demonstrated that the COVID-19 context has modified their behaviors toward food waste at the post consumption level. According to Abeliotis *et al.*⁴¹ food waste can be diminished in times of economic crises. Our data pointed out that consumers have intuitively implemented, during the COVID-19 lockdown in Ramadan, a strategy based on the 3Rs (reduce, reuse and recycle) to waste management⁴². These behaviors affect positively the level of domestic food waste¹⁹. Firstly, there was a reduction of food waste amounts at the post consumption level during Ramadan 2020. The "reduce" aspect constitutes the highest priority in the waste management hierarchy and also refers to waste prevention⁴². In fact, there was an increase in eating leftovers next day. This attitude was unexpected during Ramadan season, since leftovers are often perceived as less fresh or vulnerable to contamination³⁰. Commonly, people want to eat something new and fresh after fasting. These findings could be related to the negative economic impact of COVID-19³⁵. In times of crises such the COVID-19, leftovers could be understood as money-savers that were still good to eat and tasty²⁸. They can also be included in regular labor-saving plans of households³⁰. Moreover, Cappellini⁴¹ has established analogies between leftovers' consumption and the process of sacrifice, which might be compatible with spiritual aspects of Ramadan. A set of practices (classifying, selecting, storing and reusing) is required for consumption of leftovers in order to convert them from polluted to clean food read miscible to the table⁴³. Romani *et al.*⁴⁴ indicated that reusing leftovers and meals could contribute to lower levels of food waste. Interestingly, the Organization for Economic Co-operation and Development (OECD)⁴⁵ has included the concept of reuse within the definition of waste prevention. Redistributing edible food to the hungry could be an effective use for uneaten food.

To summarize, this study has pointed out that the COVID-19 restrictions and negative economic impacts led to a decrease in

food wastage, commonly peaking during Ramadan. Even though they kept overcooking, most of them have implemented a strategy of storing and eating leftovers during COVID-19 impacted Ramadan. For outlasting changes, food waste prevention programs should include useful tools and tips on reducing food waste and interesting recipes that make use of leftovers.

5 Conclusions

Ramadan season is a festive event where consumption increases and consequently food waste significantly increases. Results of this survey showed that the COVID-19 lockdown has induced significant improvements on consumer attitudes and behaviors toward consumption and food waste during Ramadan. In fact, the COVID-19 lockdown has positively changed consumption habits. Although Iftar menus and meals were simpler, most of respondents have not changed preparation and consumption of traditional meals and foods during Iftar. Consumers tried to find the right balance between traditions and the COVID-19 context. Interestingly, this crisis situation contributed on rising awareness toward food waste. These findings are encouraging, but they also highlighted areas for improvement, in order to sustain these new positive behaviors. Since the 1990s, Tunisia has progressed substantially in managing food waste through establishment of laws and legislations, and adoption of strategies, national programs and actions. These actions need to be revised and adopted to the current situation of urban pressure and environmental degradation.

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