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## Consumer and food changes in Mexican households during maximal contingency in the COVID-19 pandemic

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### ABSTRACT

The Coronavirus disease (COVID-19) rapidly expanded throughout the world affecting human life in the health, social, cultural, economic and environmental aspects. On an international scale, some works have addressed the importance of the agri-food topic during the pandemic, especially about food consumption. The Mexican case is particularly relevant since it is the country with the highest proportion of overweight people. The objective of this work was to know the choices and consumption of foods in Mexican households during the period of maximal contingency. An on-line questionnaire was responded by 867 volunteers who answered about the aspects taken in consideration in their food consumption, the changes in the consumption of certain foods and the socioeconomic and health aspects of the family. Four groups were identified: "Budget consumers", "Hedonics", "Price conscious" and "Conscious". Changes in the attitudes to food are not related to the health state, overweight, or family size; but are related to income level of households and above all, to the education level. Results show an opportunity to change for healthier food habits in Mexico, mainly in the most vulnerable sectors.

### Introduction

The Coronavirus disease (COVID-19) caused by the SARS-Cov-2 virus started in China in December 2019, and rapidly expanded throughout the world being declared a pandemic in March 2020 (OMS, 2020); affecting human life in the health, social, cultural, economic and environmental aspects. Since then, several research works have been generated on a global scale and from different areas of knowledge analysing its implications.

In Mexico, the first recorded case was in late February 2020 (Gobierno de México, 2020), and it was till 23 March when the initial interventions were implemented with the so called National Campaign of Social Distancing - *Jornada Nacional de Sana Distancia* (SSA, 2020a), and it was on 26 April when stricter measures were implemented in the so called Stage 3, on a national scale that consisted in the closure of all non-essential activities in the public, private and social sectors.

Differently from other countries, lockdown was not compulsory, but the population was urged to stay at home as much as possible (SSA, 2020b); and an important proportion of the population did follow the advice. Stage 3 lasted till 30 May, being followed by the New Normality with the reactivation of some non-essential activities (DOF, 2020). In

spite of measures, at the beginning of July Mexico was among the five countries with the highest number of cases and deaths (Johns Hopkins University, 2020).

Contrary to what happened in other countries where the population group with more deaths was the elderly (OMS, 2020), 67% of deaths in Mexico are related to a co-morbidity as diabetes, cardiovascular disease, and problems due to obesity and overweight (SSA, 2020c). International work reported that people with diabetes and concurrent diseases are more vulnerable to get severe symptoms of Covid-19 and a higher death risk (Gupta et al., 2020).

In this sense, the Mexican population is particularly vulnerable since it is the country with the highest prevalence of overweight people (between 15 and 75 years old) (OECD, 2017). The National Health Survey (2019) (Encuesta Nacional de Salud, 2019) showed that 75.2% of adults over 20 years old are overweight or obese (39.1% overweight and 36.1% obese), and 10.3% have diagnosed diabetes. This situation will worsen in the future given the proportion of young people with obesity (30% of children and 40% of adolescents), a situation that is associated with socioeconomic factors (Levausser, 2015).

To ameliorate this situation, since some years ago the health sector has initiated campaigns to reduce obesity through enhanced awareness

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and the establishment in 2014 of a special tax (IEPS) on foods with high caloric content (Gobierno de México, 2017), unfortunately without success on health improvement and overweight reduction.

Given the particular health situation in Mexico, it would be expected that at least during the contingency period people would be more aware of their eating habits; pointing to the importance of studying the eating behaviour during the maximal period of health contingency in the pandemic, which also represent a unique laboratory, a quasi-experiment study (Annweiler et al., 2020).

On an international scale, some works have addressed the agri-food topic during the pandemic. These works may be classified in two groups. There are theoretical studies that addressed aspects as the advantages of household home gardens (Sofa and Sofa, 2020), the impact in agri-food systems (Tanveer, 2020) or the possible transmission of COVID-19 through the food (Rizou et al., 2020).

The second group are empirical studies through on-line questionnaires as one undertaken in China that analysed the perception towards health and risky foods (Xie et al., 2020), or the one in Tunisia on the effect of consumer awareness, attitudes and behaviours related to food wastage (Jribi et al., 2020). An analysis of food consumer spending was carried out in Great Britain thanks to the use of personal financial applications (Chronopoulos et al., 2020), the work on food choices and attitudes towards food preparation by consumers in Spain (Romeo-Arroyo et al., 2020; Laguna et al., 2020); food behaviour and consumption in Qatar (Hassen et al., 2020) and United Arab Emirates (Radwan et al., 2020); and the effect of the stress on food choice motives in United States (Shen et al., 2020).

Food research and the food industry have many challenges on the COVID-19 pandemic, so that research on different food topics is required (Rizou et al., 2020) in different countries. Research on food consumption in Mexico during the pandemic will contribute on a global scale to the knowledge of eating behaviour of people during the pandemic. Therefore, the objective of this work was to know the choices and consumption changes of foods in Mexican households during the period of maximal contingency due to the COVID-19 pandemic.

## Material and methods

### Survey

An invitation to participate in the survey was sent to the researchers' contacts on Facebook and e-mailed to family, friends and colleagues, with a request to forward the invitation to people that could be interested in participating in the survey (Hardy et al., 2018). The survey was also disseminated through institutional and private social networks (Di Renzo et al., 2020). The questionnaire was available on-line for a full month, from 29 April to 29 May, during Stage 3 or period of maximal contingency, available through the Survey Monkey platform (Hardy et al., 2018).

A total of 867 questionnaires were responded, six were eliminated since they were answered by Mexicans living abroad, so that the final number considered was 861 questionnaires.

### Questionnaire

The questionnaire had four sections. The first section was based on the Food Choice Questionnaire (Stephens et al., 1995), where through 26 items participants were questioned on the aspects taken in consideration in the household for food consumption during the contingency. Answers were in a three points scale (1 = Not important, 2 = Indifferent, and 3 = Important) (Table 1). The second section asked about changes in the consumption of certain foods. The third section addressed the socio-economic and health aspects of the family. Finally, to complement the information respondents were asked for a free comment or thoughts on their eating habits and food consumption during this period. Some testimonies were included to complete information (Moro and Lamarque,

**Table 1**

Name of the obtained factors and the correspondent variance.

Factor	Items that constitute each factor	Total of the explained variance	
		Variance	Accumulated variance
Weight control	Low in calories Low in fat That help me control my weight Low in sugar	12.188	12.188
Not industrialised	Fresh foods No chemical preservatives Not industrialised	9.721	21.909
Economics	Inexpensive Good quality/price relationship Price taken into account	9.154	31.063
Fresh foods	Foods from local markets and <i>tianguis</i> (Itinerant outdoor markets) Organic foods Knowledge of production area	8.860	39.923
Health	Rich in vitamins and minerals Rich in proteins Took into consideration health advice during the contingency	7.837	47.760
Hedonism	Choose them for their flavour Tasty	7.688	55.448
Industrialised foods	Bought in shops and supermarkets Known brands	6.528	61.977
Items eliminated from the results of commonalities from the factor analysis	Foods easy to cook With nutritional information labels Local products Non-polluting packaging Packaged or tinned Available near my house		

2020) of the identified groups.

The level of income per household was taken into account, since income is usually correlated with other social determinants as social class, occupation, education, self-identity and consumption, such that The Organisation for Economic Co-operation and Development (OECD) classifies households in four according to level of income in relation to mean national income: poor (less than 50%), low income (50–75%), middle class (75–200%), and the high-income stratum (above 200%) (OECD, 2019). Income data for 2019 were considered (INEGI, 2019).

### Data analysis

To characterize the 861 Mexican families and to identify the relationship among the items of the Food Choice Questionnaire (Stephens et al., 1995; Fotopoulos et al., 2009) a factor analysis (FA) was performed. To extract the factors, the principal component (PC) method was used (Field, 2013). The 26 items of the Food Choice Questionnaire were originally selected; however, only those with a communality greater than 0.5 were retained. Therefore, twenty items were considered in the final analysis. The Kaiser-Meyer-Olkin index value of 0.5 or above was used as criteria to fulfil the conditions of parsimony and interpretability of FA and that Bartlett's sphericity value was significant ( $P < 0.05$ ). In addition, the orthogonal rotation of maximum variance (Varimax) was used to simplify the interpretation of the obtained factors (Field, 2013). Based on the factorial loads obtained from the PC analysis,

a hierarchical cluster analysis was carried out to define groups of Mexican households (Steptoe et al., 1995).

To measure the similarity among consumers and to group them, the Ward and Euclidean distance methods were used (Hair et al., 2014). The number of groups was defined based on the generated dendrogram and the associated graph of the Euclidean distances (Hair et al., 2014). To compare the groups in relation to the seven factors identified, a non-parametric Kruskal-Wallis test was conducted and the differences among groups were analysed through pairwise comparisons (Field, 2013).

The median and interquartile range was used as measure of central tendency and dispersion, since the items were recorded in an ordinal scale. The reliability of the Likert-type scale used to measure the items was ascertained through the Cronbach's coefficient (Field, 2013). Finally, socioeconomic characteristics of each group were analysed and compared using descriptive statistics (Skuras and Vakrou, 2002). The analyses were done in XLSTAT 2014 (Addinsoft).

The anonymous nature of the survey did not allow to trace any personal data; therefore, the present web survey did not require approval by an ethics committee (Di Renzo et al., 2020).

## Results

### Factor and cluster analysis

The multivariate factor analysis performed to identify the relationships among the 26 items of the Food Choice Questionnaire omitted six items from the results of the commonalities. The 20 items chosen were the ones that contributed most to the explained variance of the model (61.977%) (Table 1). Factors were named as: *Care for Weight*, the items that build up this factor are related to the consumption of food products low in calories, low in fat, low in sugar and that help weight control; *Not industrialised*, composed by the search for fresh foods; *Economics* reflects care for food prices and a good quality/price relationship; *Fresh foods*, consisting of aspects related to foods easy to find in local shops that mainly sale fruits and vegetables; *Health* related to the search of foods rich in vitamins, minerals, proteins and considering the health advice during the contingency; *Hedonism* concentrates the aspects related with taste and flavour of foods; and *Industrialised foods*, usually, it is in supermarkets where industrialised foods are mainly sold.

The results of the Factor Analyses were used to perform a Cluster Analysis. Four groups of families were identified. Fig. 1 shows graphically differences among groups. In general, it shows the little importance that the four groups gave to *Industrialised foods*, and, except for Group 1, the high regard for *Hedonism*.

Once clusters were identified, the socioeconomic characteristics per group were analysed. There were no significant differences ( $P > 0.05$ ) for Weight and Comorbidity that means that these are transversal

problems for the Mexican population. There were also no statistical differences for Family Size.

There were statistically significant differences ( $P < 0.0016$ ) for income level. Group 1 tended to be significantly with lower incomes compared to the other three groups that were of middle and high incomes.

There were also significant differences ( $P < 0.0431$ ) for both types of household heads. Group 1 households had significantly more basic education, and lower proportion of university education. Groups 2, 3 and 4 were more homogeneous in a higher educational level, although Group 4 had a significantly less proportion of only basic education, and non-significantly, a higher proportion of university education (Table 2).

### Changes of consumption per cluster

Variations in food consumption per Group were established (Fig. 2). In all groups there was a trend to reduce consumption of alcohol and soft drinks, and to increase consumption of vegetables and fruits, while the other food categories tended to remain constant.

### Groups identified

The groups were named according to all previous information, as follows: "Budget consumers", "Hedonics", "Price conscious" and "Conscious".

*Grupo 1 "Budget consumers"*. It is the smaller group formed by 7.8% of the sample, and the one more different than the other groups. Families in this group have lower incomes and lower education level. Identified factors were less important for this group, except for the *Not industrialised* foods. Economic hardships make this Group not to considered *Hedonism* or *Weight control* but were aware of the *Health* factor.

Households in this group stated a larger reduction in soft drinks and alcohol beverage consumption but is the group where the consumption of *tortillas* and other maize products is sustained in almost 87% of families, and egg consumption sustained by 67.2% of households.

Testimonies in this group were related to health, reduction in the consumption of soft drinks and the inclusion of local foods, but also noted economic aspects:

"Prices and job losses were up, and wages down so that we ate what we could buy"; "Although we would like to eat well and adequate foods, money is not enough"; "Our eating has been neglected due to the economic situation".

The other three groups had socioeconomic coincidence in level of income, co-morbidities and body weight; however, these are noted for the level of importance given to the identified factors, variations in food consumption, and education level.

*Group 2 "Hedonics"*. This group was the most numerous with 38% of participating households, who privileged *Hedonism* over the other variables. It is noteworthy the low importance given to *Weight control*, although the contrary is shown for *Health*. In terms of changes in food consumption, the higher proportion of variation was in the reduction in the consumption of soft drinks and alcohol beverages, and although in a less proportion than other groups, increased consumption fruits and vegetables.

Testimonies of this group, besides reflections on health, highlighted cooking at home.

"The fact that we are all at home gave us the opportunity to try new dishes, taking into consideration eating more nutritive meals"; "The economic crisis has been difficult, but having more time available promoted creativity to improve the variety of our meals"; "I am eating more self-cooked meals than usually"; "I have cooked more. The time we use in preparing our food is a human right that changes the quality of peoples life"; "I now have time to cook and so eat more complete and safe foods"; "Food is tastier and more nutritive because it is cooked at home"; "There

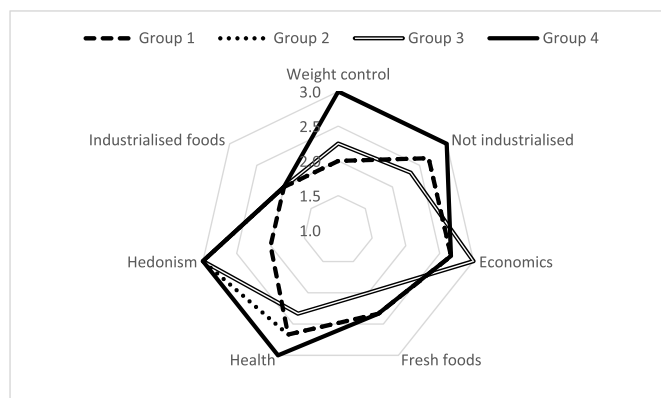


Fig. 1. Characteristics of the groups according to identified factors.

**Table 2**  
Socioeconomic and health characteristics by identified Group.

		Group 1	Group 2	Group 3	Group 4	P
		N = 67	N = 327	N = 168	N = 299	
Income level of households	Very low	26.9 (+)	9.8	13.1	8.7	0.0016
	Low	43.3	37.3	36.9	36.1	
	Middle	26.8 (-)	44.0	42.3	44.1	
	High	3.0 (-)	8.9	7.7	11	
Educational level	Basic	23.2 (+)	14.7	15	9.5 (-)	0.0431
	Middle	21.0	20.2	15.9	15.4	
	University	47.1(-)	58.4	60.9	64.9	
	Unanswered	8.7	6.7	8.2	10.5	
Family size	Small (1-2)	17.9	21.1	21.4	23.4	0.2123
	Medium (3-5)	41.8	53.2	56.0	53.8	
	Large (6-8)	25.4	17.7	17.3	14.7	
	Atypical data	14.9	8.0	5.4	8.0	
Weight	Normal	64.2	61.2	51.8	60.5	0.1543
	Overweight	35.8	38.8	48.2	39.5	
Disease	None	47.8	52.6	51.8	52.8	0.8691
	Diabetes	10.4	8.6	11.9	10	
	Cardiovascular disease	14.9	19.0	20.2	16.4	
	Diabetes and cardiovascular disease	20.9	15.3	13.1	15.1	
	Comorbidity	46.3	42.8	45.2	41.5	
	Other	0	6.0	4.6	3.0	

Values (+) or (-) indicate if the observed frequencies are higher or lower than the theoretical frequencies according to Chi-square test.

Income level of households Observed Chi-square = 26.5716; Theoretical Chi-square = 16.9190; Degrees of freedom = 9.

Educational level: Observed Chi-square = 17.3781; Theoretical Chi-square = 16.9190; Degrees of freedom = 9.

Family size: Observed Chi-square = 12.0172; Theoretical Chi-square = 16.9190; Degrees of freedom = 9.

Weight: Observed Chi-square = 5.2511; Theoretical Chi-square = 7.8147; Degrees of freedom = 3.

Disease: Observed Chi-square = 6.8225; Theoretical Chi-square = 21.0261; Degrees of freedom = 12.

*is more time to savour food, so that we prepare tasty food although it may take longer to cook*

**Group 3 "Price conscious".** These were 19.5% of households. Factors given more importance by this group were *Hedonism* and *Economics*. They also gave less importance to *Health*, *Fresh food*, and *Not industrialised*.

In relation to changes in foods, the consumption of fruits and vegetables increased, and a larger proportion of households reduced consumption of alcohol beverages, and although to a lesser extent than the other groups, they also reduced their consumption of soft drinks.

Many of the testimonies in this group do effectively emphasize their economic concerns:

*"Everything is very expensive and it is complicated to find some foods"; "The price of basic foods increased"; "We noticed a high increase in prices and shortages in my village"; "It is difficult to find healthy foods at a good price"; "Very soon we will not have to eat, because unfortunately we live day by day and if there is no income there is no food"; "To cook just what is needed, and use left-overs so that there is no wastage"; "Food prices increased almost 40%"; "We try our food to be balanced and within our budget".*

**Group 4 "Conscious".** They represent 34.7% of participant households. It is the group with the highest values in most factors. They give high importance to *Weight control*, *Health* and *Not industrialised*, as well as *Hedonism*. It is interesting that it is this group with the highest increase in the consumption of fruits and vegetables, and the reduction not only in the consumption of soft drinks and alcohol beverages, but also other sugary drinks, biscuits, and sweets.

As the other groups, it is formed by families whose members have health and overweight problems, and as the two former groups, they are middle and high-income households. However, it is the group with the lower proportion of family heads with only basic education.

The level of awareness in this group is high, and there are many testimonies on health and weight control.

*"We cook healthier and more conscious"; "We try to eat salads at lunch and fruit in the evening to care for our weight"; "Balanced meals trying to*

*decrease the consumption of fats, sugar, and carbohydrates"; "It is important to care for our health"; "To develop ideas to keep varied meals and not gain weight, avoiding refined flours and eating as natural and fresh foods as possible"; "I only try to cook more and at ease, trying not to use many processed foods ... we are now trying to avoid junk foods"; "Trying to increase our body defences through proper foods in the face of this contingency"; "The opportunity to reflect on food and health"; "My family and I started an eating plan low in calories and try to exercise not to have high glucose levels".*

Testimonies of this Group mentioned the importance of organic foods, and also the implementation of home gardens. Their level of awareness coincides with the current ethical values that go beyond the individual, being interested in actions that have a social impact by suggesting the need for policies and research on these aspects.

*"Foods that damage health should not be sold"; "There should be a public campaign on good eating habits since problems as diabetes and obesity make people vulnerable to COVID"; "Thank you for researching this topic"; "Thank you for your interest in these issues, they are important".*

## Discussion

The factors Identified in the present work have been reported in other studies on food choice consumption in normal circumstances in different parts of the world (Januszewska et al., 2011; Milošević et al., 2012), even in Mexico, where ten factors were detected: Care for weight and health, Social sensitivity, Practicality, Economics, Non industrialised, Hedonism, Traditionality A, Familiarity, Traditionality B, and no sugar (Espinoza-Ortega et al., 2016).

During the pandemic period, Shen et al. (2020), studying consumers in United States during the pandemic period, identified five food choice motives associated with emotional eating: mood, convenience, sensory appeal, price, and familiarity. The work herein reported coincides with the Hedonism aspects.

Regarding the groups, other works has also identified consumer groups. In Spain, Romeo-Arroyo, Mora & Vázquez-Araújo (2020)

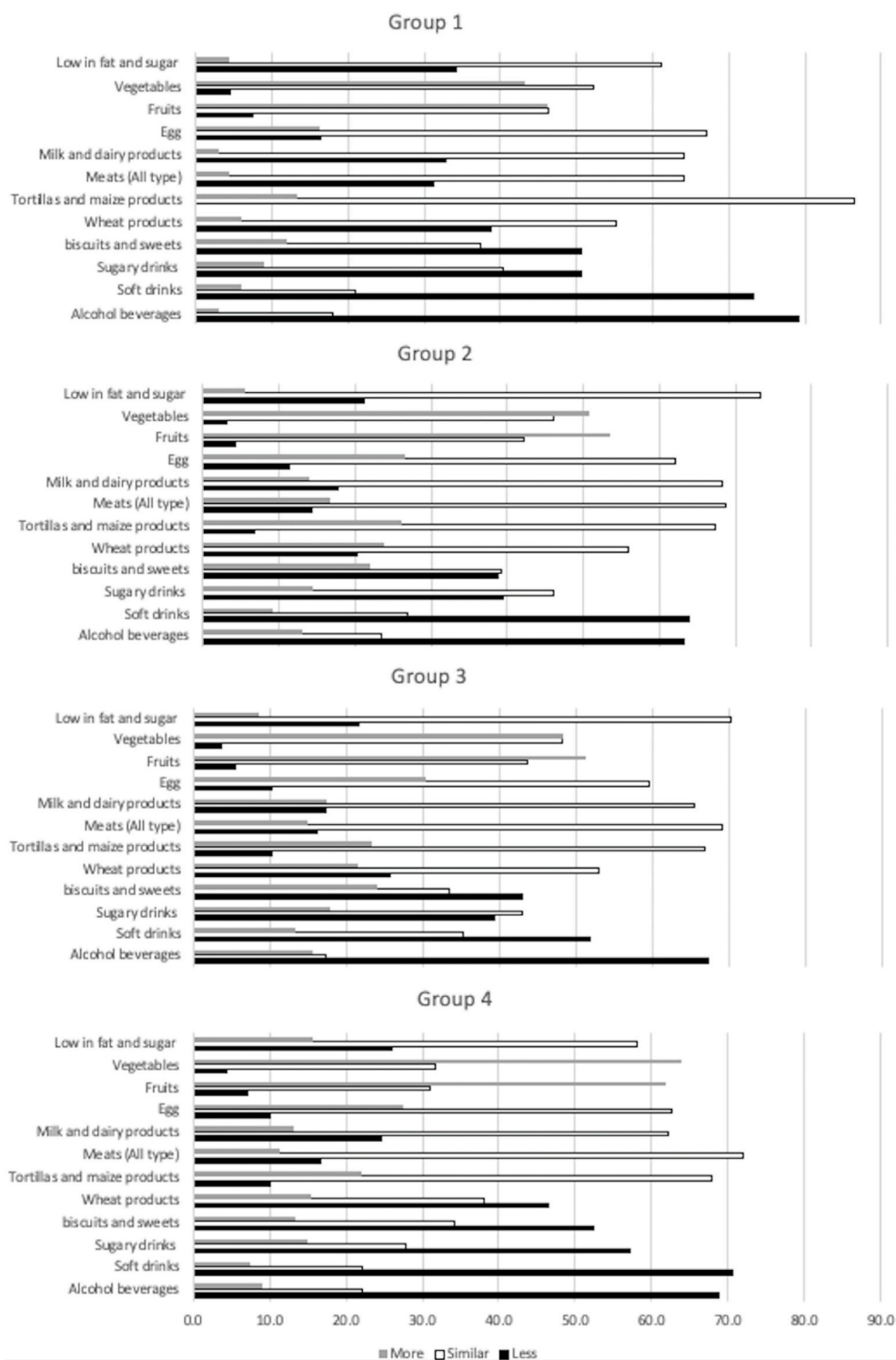


Fig. 2. Changes of consumption of different food categories per identified groups.

identified three consumer groups named: Self-control, characterized by choosing foods mainly by their health properties; Sensitive who gave importance to the pleasant character of the food they chose; and Non emotional characterized by the lowest scores in the mood related sentences. In the same way, Di Renzo et al. (2020), in Italy, identified three groups too. Mediterranean-like, related as a healthier diet; Western-like and Low fruit/vegetables.

Coincidences among the Spanish, Italian and Mexican cases are interesting, where consumers have positive attitudes in choosing their

foods for their health attributes. It can be said that, in general, there is sensitivity towards the consumption of healthier diets in the pandemic. However, other works mentioned opposite attitudes, as the study of Rawdan et al. (2020) in United Arab Emirates, where non healthy eating habits increased during the COVID-19 contingency, being the most common increased food intake.

Concerning the characteristics of the groups, the work from Spain did not establish what aspects determined the differences among the identified groups, and the study from Italy only mentioned that consumers of

the Mediterranean diet were between 18 and 30 years old (Di Renzo et al., 2020). In the present study there is an effect of socioeconomic variables. Firstly, the 'Budget consumers' group had a low representation, related to a lower income and educational level, both related to access to technology. Hassen, Bilani & Allahyary (2020), established that their questionnaire was answered mostly by young people with a high educational level, who have more access to internet and social networks.

This group with the more precarious situation resorts to basic and easily affordable foods like maize products and eggs. Maize is the staple food in Mexico, with a *per capita* consumption of 196 kg/year mostly as *torillas* (SAGARPA, 2016), but it is even more essential for the lower income sectors. It is the same situation with the consumption of eggs, a widely available and inexpensive food with a high nutritional value that is prevalent in the Mexican preferences, with a yearly consumption of 33.12 kg per person, more than one egg a day. This makes Mexico as the country with the highest consumption of eggs (UNA, 2020). Given the difficult economic situation for a large proportion of the Mexican population where 41.9% are poor and 7.4% are extremely poor (CONEVAL, 2020), both foods are an affordable option, even more in a time of crisis.

Concern on the economic issues is understandable since, during the contingency period, basic foods had a 50% increase in price (Forbes, 2020a), and people in poverty increased by 7.7% during the second quarter of 2020 (CONEVAL, 2020). Changes in the consumption of some foods are probably due in part to economic issues, at least in this group. Al respect, FAO mentioned in March 2020 that the most impoverished population would be the most affected by COVID-19 from disruptions in food systems, as this segment of the population is more vulnerable to direct and indirect impacts to food security (FAO, 2020a).

In the other groups, it is noteworthy the level of awareness of Group 4 – 'Conscious' particularly when the similarities with groups 2 and 3 in level of income are considered. Otherwise, Group 4 had the lowest proportion of family heads with only basic education, and with the highest proportion of university education (64.9%), which was noted in the more reflective and elaborated testimonies. The OECD established that the level of income is usually correlated with other social determinants, among those, the educational levels (OECD, 2019). In the work herein reported, the small differences in education are determinant in the degree of consciousness.

In the same way, Brunner and Siegrist (2011) established that the educational and economic level influence life-styles, which are linked to products and services in the achievement of established or new values in current societies, like those observed in the 'Conscious' group. Some reflections mentioned by the interviewed consumers agree with what Gómez-Benito and Lozano (2014) called "citizen consumer", consumers capable of fulfilling their desires and promoting collective responsibility and a common good at once. Their consciousness level coincides with the new ethical values that go beyond the individual, getting involved even in actions that have a social effect through policies and research.

It is relevant that an aspect commonly mentioned during the pandemic was environmental issues and the need to reflect on how food is produced (Altieri and Nicholls, 2020; Sofo and Sofo, 2020; Tanveer, 2020). In our work, the 'Conscious' Group mentioned the importance of consuming organic products and even implementing home gardens. In this respect, the Italian study found that 15% of respondents turned to farmers or organic purchases (Di Renzo et al., 2020). Xie, Huang, Li & Zhu (2020) found that in China the COVID-19 crisis influenced the respondents' perception towards organic foods, being the older generation who have a more positive attitude and higher willingness to increase their future eating frequency. Sofo and Sofo (2020) mentioned the opportunity for urban agriculture, not only to supply foods, but also for the occupation of people. It is established that it could be a trading opportunity to meet sustainability goals, that should be a priority aspect for local governments in developing countries (Xie et al., 2020).

The larger trend identified in studies reported on this contingency period has been on changes in the consumption of foods towards

healthier diets. The work of Di Renzo et al. (2020) in Italy has coincidences with our current work. Their data show increases in the consumption of legumes, cereals and white meat, and a decrease of packaged sweets, alcohol intake, baked products, and fresh fish.

In the same way, Hassen et al. (2020) in their work in Qatar, established that more than a third of the respondents increased their consumption of fruits and vegetables, ate more healthy food and decreased their consumption of snacks. On the other hand, work in Spain by Romeo-Arroyo et al. (2020), showed that most consumers reported a similar consumption of most of the food categories except for fruits and fish whose consumption was increased. Laguna et al. (2020) from work also in Spain, found an increase in the purchase of pasta and vegetables, ascribing these changes to the need for a healthier diet and body weight control.

However, in Spain, also consumption of sweets was increased by more than 50% (Romeo-Arroyo et al., 2020). In Italy, increased appetite and snacks consumption was in the young people, mostly during the night (Di Renzo et al., 2020).

Regarding the consumption of beverages, Hassen et al. (2020) found that nearly half of the respondents drank more water during the contingency in Qatar. Although there was no specific question on water consumption in our work, the consumption of water may have increased as the consumption of soft drinks was reduced. A relevant aspect since as from 2010, Mexico is the country with the largest consumption per person of soft drinks (Coca-Cola, 2012), which led the government to implement a special tax to these beverages (Gobierno de México, 2017). Sánchez-Romero et al. (2020) mentioned this tax's effectiveness in reducing the consumption of sugar-sweetened drinks in Mexico. The same occurred in Portugal, where taxing sugary drinks produced a high impact on the population diets and reduce obesity (FAO, 2020b). The reduction in the contingency period means that consumption of soft drinks could be reduced more, by economic measures (taxes increasing price) and health concerns.

Innovative studies have enabled the record of these changes in food consumption. Eftimov et al. (2020) analysed the food preparation recipes published before and during the quarantine, on Allrecipes – the largest food social network (Cuisine from 24 countries and 1.5 billion visits per year), using a methodology based on artificial intelligence. The approach used the recipe preparation description that provided a list of main ingredients annotated using semantic tags. They compared the food consumption patterns before and during the pandemic, comparing the ingredients' relative frequency that composes the recipes. Results showed changes in food consumption patterns. There was an increase of legumes, pancakes and soups, and the most considerable reduction was on some types of fish, corn/cereal grains and wine-making.

Delivery service during the contingency has been considered in other studies as Troise et al. (2021). In México the restaurants were closed, but delivery service was allowed. Notwithstanding, the use of the apps for food delivery grew 44% during the contingency (Marketing4cimmerce, 2020), in the present work, there were no comments by the interviewees on the use of those platforms. Perhaps it is a practice still in development and not usual among the entire population, so there was no other option than self-cooking meals.

In that sense, a work in Spain on the analysis of the trending searches on the internet during the first months of 2020, found that search in relation with food showed a more than usual increase in popularity (Laguna et al., 2020), which denotes the importance that food and cooking have had during this period.

It is relevant to note how the act of cooking was perceived. In the Mexican case herein reported, being able to cook at home, having more time was a pleasant activity that also enabled enjoying food with the family. On this, Italians mentioned that during the lockdown they had more desire to cook (Di Renzo et al., 2020); and in Qatar, respondents said that they cooked and prepared food at home much more frequently and even stated they were spending much time cooking that had turned into a new entertainment activity (Hassen et al., 2020). Most of the cases

reported the rediscovery of home cooking (Borsellino et al., 2020). Nevertheless, on their part Romeo-Arroyo et al. (2020) found in Spain a segment of consumers for whom cooking was more duty than pleasure.

Radwan et al. (2020) stated that cooking at home could change dietary habits. Bad eating habits are undoubtedly a problem that needs multiple solutions, that involve individual awareness where families play a relevant role but it is also a government concern. It has been some years now that the need to change the diet of younger generations has been discussed, given the vulnerability of young people to consume unhealthy foods. It was suggested that there should be policies to re-orient eating habits and behaviour (Casini et al., 2013).

That is why several countries have implemented some measures (Sánchez-Romero et al. (2020). Mexico was one of the pioneers when the tax on foods with high caloric content was established (Gobierno de México, 2017). Other policies came into effect during the pandemic, as a new frontal labelling with nutritional information (DOF, 2020a) and in some states the ban on sales of junk foods to minors (Forbes, 2020b); pertinent but insufficient or late measures.

Results in our work showed that Mexican households did effectively show positive attitudes towards healthier diets during the time of maximal lockdown due to the COVID-19 pandemic, which may be an opportunity for change. Carrete and Arroyo (2014) established that Mexican consumers have positive attitudes towards healthy diets if they have been exposed to illness. Shen, Long, Shin & Ludy (2020), mentioned that the stress perceived contributed to better food choices. The testimonies herein reported bear witness that the pandemic made many consumers to recognise the real damage of unhealthy eating.

On the other hand, Galanakis (2020) goes further of the importance of a healthy food diet, and established the relevance of the innovation and developing functional foods fortified with bioactive compound and antioxidants to promote health and support consumers' immune system. In the last months, some research has identified that the risk for COVID-19 is higher in patients with vitamin D deficiency (Katz, 2021; Galanakis et al., 2020) and its supplementation during or before COVID-19 is associated with a better survival rate (Annweiler et al., 2020). The inclusion of functional foods or supplements was not considered in work herein reported; however, during December 2019 and January 2020 there was a scarce supply of vitamin D, due to the increase in its consumption.

The magnitude of the current pandemic has never been seen by humanity, but it is probable that similar events will happen in the future (Borsellino et al., 2020). Rawdan et al. (2020) stated that although efficient in limiting the spread of the actual virus, restrictive measures of confinement and lockdown could have detrimental consequences on the lifestyle and wellbeing of individuals, and efforts are needed to develop interventions aiming to alleviate that impact.

On their behalf, FAO (2020a) established the need to re-orient and transform the food system to be more resilient and sustainable. The Impact of COVID-19 on food security and nutrition adds to the reflection, future public strategies could be designed reflecting consumer attitudes, where healthier foods should be a national priority (Borsellino et al., 2020). Xie, Huang, Li & Zhu (2020), said that attitudes during this pandemic period had created some opportunities for positive changes in China, and more investment on a healthier food system in developing countries, where governments should prioritize the most vulnerable of their populations. Hassen, Bilani & Allahyary (2020), mentioned that even for Qatar, a rich country, there could be a positive change towards a healthier diet compared to the pre-COVID-19 situation. Undoubtedly the current situation is an opportunity for the Mexican food system too.

Although several works indicate positive trends towards an improvement in eating habits have emerged (Borsellino et al., 2020); Sheth (2020) poses the great question: will the consumers permanently change their consumption habits due to lockdown and social distancing or will they go back to their old habits once the global crisis is over? Therefore, there is a need to carry on with these investigations to analyse the consumption behaviour of people and families in the now called new

normality.

## Conclusion

Results show that there were different attitudes towards foods in Mexican households during the maximal contingency period of the COVID-19 pandemic, firstly due to income in less favoured families, while in middle and high-income households were ambivalent in attitudes towards food, related to health, hedonism, and economic aspects. However, these were not related to their health status, overweight, or family size; but were related to income level of households, and above all, education level.

The COVID-19 pandemic has created a new era and the consequences for humanity, economy and food systems are still not clear (Galanakis, 2020). This work is a contribution to the Latin American and global context on food consumption of families during the pandemic. It adds to other international research in understanding changes in food consumption and the perception of health in the lockdown situations due to the pandemic.

It falls within the new reality generated by the pandemic where the use of communication and information technologies are each day more common in all aspects of human activity.

## Limitations

The main limitation is also its main advantage during the studied period, that is, the on-line survey, since it was the only way to collect information. However, it means that a sector of the population without access to internet could not be included. Therefore, in the future and within the 'new normality' other work must be undertaken with the use of other methodologies.

## Implication for gastronomy

Food research and the food industry have many challenges during the pandemic, so that research on different food topics and in different countries is required. In the Mexican case herein reported, having more time at home and being able to cook, was a pleasant activity that also enabled enjoying food with the family. The gastronomy implications are that during the lockdown families were able to try new dishes, tastier, more nutritive and healthier, incorporating more vegetables, local products, and traditional dishes based on traditional green vegetables (*quelites*) that had been relegated from everyday dishes in favour of modern foods.

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## CRedit authorship contribution statement

**Angélica Espinoza-Ortega:** Conceptualization, Methodology, Data curation, Investigation, Writing – original draft, Writing – review & editing. **Carlos G. Martínez-García:** Formal analysis, Writing – review & editing. **Edgar Rojas-Rivas:** Formal analysis, Writing – review & editing. **Yair Fernández-Sánchez:** Data curation, Writing – review & editing. **Stefanie Y. Escobar-López:** Writing – review & editing. **Laura Sánchez-Vegas:** Writing – review & editing.

## Declaration of competing interest

We are not aware of any conflict of interests that could inappropriately influence, or be perceived to influence, the work of persons or institutions.



## References

- Altieri, M.A., Nicholls, C.I., 2020. Agroecology and the emergence of post COVID-19 agriculture. *Agric. Hum. Val.* Rapid Response Opin. 37, 525–526. <https://doi.org/10.1007/s10460-020-10043-7>.
- Annweiler, C., Hanotte, B., Grandin de l'Épervier, C., Sabatier, J.M., Lafaie, L., célarier, T., 2020. Vitamin D and survival in COVID-19 patients: a quasi-experimental study. *J. Steroid Biochem. Mol. Biol.* 204, 105771. <https://doi.org/10.1016/j.jsmb.2020.105771>.
- Borsellino, V., Kaliji, S.A., Schimmenti, E., 2020. COVID-19 Drives consumer behaviour and agro-food markets towards healthier and more sustainable patterns. *Sustainability* 12, 8366. <https://doi.org/10.3390/su12208366>.
- Brunner, T.A., Siegrist, M., 2011. A consumer-oriented segmentation study in the Swiss wine market. *Br. Food J.* 113 (3), 353–373. <https://doi.org/10.1108/00070701111116437>.
- Chronopoulos, D.K., Lukas, M., Wilson, J.O.S., 2020. Consumer Spending Responses to the COVID-19 Pandemic: an Assessment of Great Britain. Electronic copy available at SSRN. <https://ssrn.com/abstract=3586723>.
- Carrete, L., Arroyo, L., 2014. Social marketing to improve healthy dietary decisions. Insights from a qualitative study in Mexico. *Qual. Mark. Res. Int. J.* 17, 239–263. <https://doi.org/10.1108/QMR-11-2011-0023>.
- Casini, L., Contini, C., Romano, C., Scozzafava, G., 2013. Trends in food consumption: what is happening to generation X? *Br. Food J.* 117 (2), 705–718.
- Coca-Cola, 2012. Per capita consumption of company beverage products. Available at: <https://www.cocacola.com/annualreview/2011/pdf/2011-per-capita-consumption.pdf/>. (Accessed 14 June 2020).
- CONEVAL, 2020. Efectos COVID. Available at: [https://www.coneval.org.mx/Evaluacion/IEPSM/Documents/Efectos\\_COVID-19.pdf](https://www.coneval.org.mx/Evaluacion/IEPSM/Documents/Efectos_COVID-19.pdf). (Accessed 15 September 2020).
- Di Renzo, L., Gualtieri, P., Pivari, F., Soldati, L., Cinelli, G., Leggeru, C., Capareello, G., Barrea, L., Scerbo, F., Esposito, E., De Lorenzo, A., 2020. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *J. Trans. Med.* 18 (1), 229. <https://doi.org/10.1186/s12967-020-02399-5>.
- DOF- Diario Oficial de la Federación, 2020. ACUERDO por el que se establecen los Lineamientos Técnicos Específicos para la Reapertura de las Actividades Económica DOF: 29/05/2020 Gobierno de México. Consulta en línea en: [https://www.dof.gob.mx/nota\\_detalle.php?codigo=5594138&fecha=29/05/2020](https://www.dof.gob.mx/nota_detalle.php?codigo=5594138&fecha=29/05/2020). (Accessed 20 August 2020).
- DOF- Diario Oficial de la Federación, 2020a. MODIFICACIÓN a la Norma Oficial Mexicana NOM-051-SCFI/SSA1-2010. Especificaciones generales de etiquetado para alimentos y bebidas no alcohólicas preenvasados-Información comercial y sanitaria, publicada el 5 de abril de 2010. Consulta en línea en: [https://www.dof.gob.mx/2020/SEECO/NOM\\_051.pdf](https://www.dof.gob.mx/2020/SEECO/NOM_051.pdf). (Accessed 5 September 2020).
- Eftimov, T., Popovsky, G., Petković, M., Seljak, B.K., Kocov, D., 2020. COVID-19 pandemic changes the food consumption patterns. *Trends Food Sci. Technol.* 104, 268–272. <https://doi.org/10.1016/j.tifs.2020.08.017>.
- Encuesta Nacional de Salud y nutrición, 2019. Encuesta Nacional de Salud y nutrición. Gobierno de México. Consulta en línea en: <https://ensanut.insp.mx/encuestas/ensanut2018/informes.php>. (Accessed 5 September 2020).
- Espinoza-Ortega, A., Martínez-García, C.G., Thomé-Ortiz, H., Vizcarra-Bordi, I., 2016. Motives for food choice in Central Mexico. *Br. Food J.* 118 (11), 2744–2760.
- FAO, 2020a. Impact of COVID-19 on Food Security and Nutrition (FSN). Interim Issues by the High-Level Panel of Experts on Food Security and nutrition (HLPE). Available at: [http://www.fao.org/fileadmin/templates/cfs/Docs1920/HLPE\\_2020/New\\_HLPE\\_paper\\_COVID\\_EN.pdf](http://www.fao.org/fileadmin/templates/cfs/Docs1920/HLPE_2020/New_HLPE_paper_COVID_EN.pdf). (Accessed 10 September 2020).
- FAO, 2020b. Portugal brings down obesity by taxing sugary drinks. Available at: <https://www.euro.who.int/en/countries/portugal/news/news/2020/3/portugal-brings-down-obesity-by-taxing-sugary-drinks>. (Accessed 27 January 2020).
- Field, A., 2013. *Discovering Statistics using SPSS, fourth ed.* Sage Publications, Great Britain.
- Forbes, 2020a. Cuarentena incrementa precios de productos de canasta básica más del 50%. Available at: <https://www.forbes.com.mx/noticias-cuarentena-incrementa-precios-de-canasta-basica-hasta-mas-del-50/>. (Accessed 20 September 2020).
- Forbes, 2020b. Oaxaca, primer estado en prohibir la venta de alimentos chatarra a menores de edad. Available at: <https://www.forbes.com.mx/politica-congreso-oaxaca-prohibe-venta-alimentos-chatarra-ninos/>. (Accessed 20 September 2020).
- Fotopoulos, C., Krystallus, A.M., Vasallo, M., Pagialis, A., 2009. Food Choice Questionnaire (CCQ) revisited. Suggestion for the development of an enhanced general food motivation model. *Appetite* 52, 199–208.
- Galanakis, C.M., 2020. The food systems in the era of the coronavirus (COVID-19) pandemic crisis. *Foods* 9, 523. <https://doi.org/10.3390/foods9040523>.
- Galanakis, C.M., Aldawoud, T.M.S., Rizou, M., Rowan, N.J., Ibrahim, A., 2020. Food ingredients and active compounds against the coronavirus disease (COVID-19) pandemic: a comprehensive review. *Foods* 9, 1701. <https://doi.org/10.3390/foods9111701>.
- Gobierno de México, 2017. Ley de Impuesto Especial sobre Producción y Servicios (IEPS). Gobierno de México. Disponible en: [https://www.sep.gob.mx/work/models/sep1/Resource/17e0fb21-14e1-4354-866e-6b13414e2e80/ley\\_impuesto\\_especial.pdf](https://www.sep.gob.mx/work/models/sep1/Resource/17e0fb21-14e1-4354-866e-6b13414e2e80/ley_impuesto_especial.pdf). (Accessed 20 August 2020).
- Gobierno de México, 2020. Conferencia de prensa del 29 de febrero. Consulta en línea en: <https://coronavirus.gob.mx/2020/02/29/conferencia-29-de-febrero>. (Accessed 20 August 2020).
- Gomez-Benito, C., Lozano, C., 2014. Constructing Food citizenship: theoretical premises and social practices. *Ital. Sociol. Rev.* 4 (2), 135–156.
- Gupta, R., Hussain, A., Misra, A., 2020. Diabetes and COVID-19: evidence, current status and unanswered research questions. *Eur. J. Clin. Nutr.* 74, 864–870.
- Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., 2014. *A Premier on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. SAGE Publications, Great Britain.
- Hassen, T.B., Bilali, H.E., Allahyary, M.S., 2020. Impact of COVID-19 on food behaviour and consumption in Qatar. *Sustainability* 12, 6973. <https://www.mdpi.com/2071-1050/12/17/6973>.
- Hardy, M., Opreacu, F., Millea, Summers, M., 2018. Let me tell you about healthy ageing and about my quality life: listening to the baby boomers voice. *Qual. Ageing* 19 (3), 167–179.
- Januszewska, R., Pieniak, Z., Verbeke, W., 2011. Food Choice questionnaire revisited in four countries. Does it still measure the same? *Appetite* 57, 94–98.
- Johns Hopkins University, 2020. Coronavirus Resource Center. Consulta en línea en: <https://coronavirus.jhu.edu/us-map>. (Accessed 20 August 2020).
- Jribi, S., Ismail, H.B., Doggui, D., Debbabi, H., 2020. COVID-19 virus outbreak; what impacts on households food wastage? *Environ. Dev. Sustain.* 22, 3939–3955.
- Katz, J., Yue, S., Xue, W., 2021. Increased risk for COVID-19 in patients with vitamin D deficiency. *Nutrition* 84, 111106. <https://doi.org/10.1016/j.nut.2020.111106>.
- Laguna, L., Fizman, S., Puerta, P., Chaya, A., Tárrega, A., 2020. The impact of COVID-19 lockdown on food priorities. Results from a preliminary study using social media and an online survey with Spanish consumers. *Food Qual. Prefer.* 86 <https://doi.org/10.1016/j.foodqual.2020.104028>.
- Levasseur, P., 2015. Causal effect of socioeconomic status on central adiposity risks: evidence using panel data from urban Mexico. *Soc. Sci. Med.* 136–137, 165–174.
- Marketing4ecommerce, 2020. Rappi y uber eats las apps ganadoras durante el coronavirus en México. <https://marketing4ecommerce.com/rappi-y-uber-eats-las-apps-ganadoras-durante-el-coronavirus-en-mexico-fintonic/>. (Accessed 24 January 2021).
- Milosević, J., Žeželj, I., Gorton, M., Barjolle, D., 2012. Understanding the motives for food choice in Western Balkan countries. *Appetite* 8, 205–2014.
- Moro, G.L., Lamarque, M.S., 2020. Alimentación, estilo de vida y participación: un estudio etnográfico de los grupos de consumo agroecológico en Castilla y León. *Disparidades. Rev. Antropol.* 7 (1) <https://doi.org/10.3989/dra.2020.010>.
- OECD, 2017. Obesity updates 2017. OECD. [www.oecd.org/health/obesity-update.htm](http://www.oecd.org/health/obesity-update.htm). (Accessed 20 August 2020).
- OECD, 2019. Under Pressure: the Squeezed Middle Class. Under Pressure: The Squeezed Middle Class. Paris. <https://doi.org/10.1787/689afed1-en>. (Accessed 20 August 2020).
- OMS- Organización Mundial de la Salud, 2020. Información coronavirus-2020. Consulta en línea en: <https://www.who.int/es/emergencias/diseases/novel-coronavirus-us-2019>. (Accessed 20 August 2020).
- Radwan, H., Kiti, M.A., Hasan, H., Hilali, M.A., Abbas, N., Hamadeh, T., Saif, E.R., Naja, F., 2020. Diet and lifestyle changes during COVID-19 lockdown in the United Arab Emirates: results of a cross-sectional study. *BMC Publ. Health.* In review. v1. <https://www.researchsquare.com/article/rs-76807/v1>.
- Rizou, M., Galanakis, I.M., Aldawoud, T.M.S., Galanakis, C.M., 2020. Safety on foods, food supply chain and environment within the COVID-19 pandemic. *Trends Food Sci. Technol.* 102, 293–299. <https://doi.org/10.1016/j.tifs.2020.06.008>.
- Romeo-Arroyo, E., Mora, M., Vázquez-Araújo, L., 2020. Consumer behaviour in confinement times: food choice and cooking attitudes in Spain. *Int. J. Gastronomy Food Sci.* 21 (100226) <https://doi.org/10.1016/j.ijgfs.2020.100226>.
- SAGARPA, 2016. Maíz granos blanco y amarillo mexicano. Planeación Agrícola Nacional 2016-2030. SAGARPA, Gobierno de México.
- Sánchez-Romero, L.M., Canto-Osorio, F., González-Morales, R., Colchero, M.A., Ng, S.W., Ramírez-Palacios, P., Salmerón, J., Barrientos-Gutierrez, T., 2020. Association between tax on sugar sweetened beverages and soft drink consumption in adults in Mexico: open cohort longitudinal analysis of health workers cohort study. *Br. Med. J.* 369, m1311. <https://www.bmj.com/content/bmj/369/bmj.m1311.full.pdf>.
- Sheth, J., 2020. Impact of COVID-19 on consumer behaviour: will the old habit return or die. *J. Bus. Res.* 117, 280–283. <https://doi.org/10.1016/j.jbusres.2020.05.059>.
- Shen, W., Long, L.M., Shin, C., Ludy, M., 2020. A humanities-based explanation for the effects of emotional eating and perceives stress on food choice motives during COVID-19 pandemic. *Nutrients* 12, 2712. <https://www.mdpi.com/2072-6643/12/9/2712>.
- Skuras, D., Vakrou, A., 2002. Consumers' willingness to pay for origin labelled wine. A Greek case of study. *Br. Food J.* 104 (11), 898–912. <https://doi.org/10.1108/00070700210454622>.
- Steppe, A., Pollard, T., Wardle, J., 1995. Development of a measure of the motives underlying the selection of food: the Food Choice Questionnaire. *Appetite* 25, 267–284. <https://doi.org/10.1006/appe.1995.0061>.
- Sofo, A., Sofo, A., 2020. Converting home spaces into food gardens at the time of COVID-19 quarantine: all benefits of plants in this difficult and unprecedented period. *Hum. Ecol.* 48, 131–139. <https://doi.org/10.1007/s10745-020-00147-3>.
- SSA, 2020a. Jornada Nacional de Sana Distancia. Comunicado 22 de marzo del 2020, Gobierno de México. [https://www.gob.mx/cms/uploads/attachment/file/541687/Jornada\\_Nacional\\_de\\_Sana\\_Distancia.pdf](https://www.gob.mx/cms/uploads/attachment/file/541687/Jornada_Nacional_de_Sana_Distancia.pdf). (Accessed 20 August 2020).
- SSA, 2020b. Inicia la fase 3 por COVID-19. Comunicado 110–121 de abril del 2020, Gobierno de México del 2010. En: <https://coronavirus.gob.mx/2020/04/21/inici-a-la-fase-3-por-covid-19-2/>. (Accessed 20 August 2020).
- SSA, 2020c. Informe diario COVID-19. Comunicado de prensa 23 de julio del 2020, Gobierno de México del 2010. En: <https://coronavirus.gob.mx/2020/07/23/conferencia-23-de-julio/>. (Accessed 20 August 2020).
- Troise, C., O'Driscoll, A., Tani, M., Prisco, A., 2021. Online food delivery services and behavioural intention – a test of an integrated TAM and TPB framework. *Br. Food J.* 123 (2), 664–682. [OI 10.1108/BJFJ-05-2020-0418](https://doi.org/10.1108/BJFJ-05-2020-0418).

Tanveer-Hossain, S., 2020. Impacts of COVID-19 on the agri-food sector: food security policies of Asian productivity organization members. *J. Agric. Sci.* 2, 116–132.

UNA-Unión Nacional de Avicultores (2020) <https://una.org.mx/industria/> Accessed 20 5 September 2020.

Xie, X., Huang, L., Li, J., Zhu, H., 2020. Generational differences in perception of food health/risk and attitudes toward organic food and game meat: the case of COVID-19 crisis in China. *Environ. Res. Public Health* 17, 3180.