Jordan Journal of Applied Science
Natural Science Series

*Research Article*

# Impact of the COVID-19 pandemic on plant-based food and supplement consumption among Jordanians and Iraqis: A retrospective evaluation

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ARTICLE INFO

**Article history:**
Received 3 Jun 2024
Accepted 30 Jun 2024
Published 30 Jun 2024

**DOI:** doi.org/10.35192/jjoas-n.v18i1.1855

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**Keywords:**
Fruits and vegetables
Diet
Dietary supplements
Herbs and spices
Grains and nuts

ABSTRACT

**Background:** This study investigates the intake of plant foods (vegetables, fruits, grains, nuts, and their oils, along with herbs and spices), honey, vitamins, and food supplements in Iraq and Jordan during the COVID-19 pandemic.

**Methods:** This cross-sectional questionnaire-based study was conducted in Iraq and Jordan among people of different backgrounds and age groups from March 2021 to April 2021 to evaluate the effect of the COVID-19 pandemic on their consumption attitudes towards fruits, vegetables, herbs, vitamins, and dietary supplements.

**Results:** A total of 1,083 participants were included in the present study. One hundred sixty participants (14.8%) from Jordan and 152 participants (14.0%) from Iraq were infected with the virus SARS-CoV-2, collectively accounting for 28.8% of the respondents. To protect themselves from the COVID-19 pandemic, 71.7% increased their fruit consumption, followed by those who used vitamins and dietary supplements (67.7%) and those who increased their vegetable consumption (67.4%). Additionally, 53.7% of participants increased their consumption of grains and nuts, 50.1% increased their consumption of honey and oils, and 50.0% increased their consumption of herbs and spices.

**Conclusion:** The study confirmed that there was a notable increase in the use of plant-based nutrition among the inhabitants of both countries. This indicates an awareness among the people concerning the health benefits of plant foods in reducing the risk of developing infectious diseases.

## Introduction

Since the first reports on the pneumonia-like disease of unknown cause in Wuhan, China in December of 2019, tens of thousands of review articles, short communications, and case and clinical reports have appeared addressing the scientific communities as well as laymen on the diagnosis, transmission, epidemiology, etiology, pathophysiology, treatments (conventional and traditional) and vaccines (1-6). This novel type of coronavirus called COVID-19 by the WHO (World Health Organization) is an enveloped RNA virus (7,8). It is also known as 2019-nCoV which was later changed to SARS-CoV2 (Severe Acute Respiratory Syndrome Corona Virus 2) by the ICTV (International Virus Taxonomy Committee) (9).

The clinical features of those infected with COVID-19 include coughing, shortness of breath, congestion, fatigue, headaches, fever, loss of taste or smell, loss of appetite, diarrhea, vomiting, and more severe symptoms like confusion, bluish face, and inability to wake or stay awake (10). Further complications of COVID-19 include ARDS, respiratory failure, liver injury, acute myocardial injury, acute kidney injury, septic shock, and even multiple organ failure (4).

In March 2020, WHO declared this disease as a global pandemic (11). The use of antiviral drugs together with the supportive therapies saved the life of millions of infected individuals worldwide. Since equitable access to safe and effective vaccines is critical to ending the COVID-19 pandemic, several brands of safe and effective vaccines have been approved by the WHO in a very short time. On an individual level, it is essential to strengthen the immune system and adapt a healthy lifestyle to lower the infection rate and avoid severe or long-term complications of the disease (12, 13).

The primary function of the immune system is to maintain and protect the health of an individual's body by keeping its tissues and cells safe, but despite that, the immune system sometimes fails to maintain its function. Therefore, it is essential to support the immune system by maintaining a healthy lifestyle such as having adequate sleep and exercise and eating a healthy diet (13-15). Many studies have shown that plants and their bioactive constituents with their immunomodulatory effects could protect the body from diseases, including those related to inflammatory and oxidative processes and viral infections (13, 16-18). Also, dietary supplements and various vitamins can help to enhance the immune system, especially for those who have some difficulty in consuming fruits and vegetables, such as young children and elderly people, or those who follow a rigorous diet such as kidney failure or heart failure patients (12, 19, 20). Vitamin C, a standard ingredient in many dietary supplements, is involved in the proper functioning of different enzymatic reactions, plays a protective role in the respiratory tract system, and counteracts immune system deficiencies (21). Another vitamin that plays a vital role in the immune system response is vitamin D. It is well accepted that vitamin D metabolites are involved in the stimulation of the innate immune system, a major part of the body's immune defense. The innate immune response is also important for activating the acquired immune system (22, 23).

As mentioned earlier, the benefits of a healthy diet, dietary supplements and vitamins are well known and have been intensively studied over the years. These include strengthening the immune system, combating infectious diseases and improving overall health. The present study aimed to gain insight into the attitude of the inhabitants of Iraq and Jordan if the COVID-19 pandemic, and how it has influenced their eating habits with regard to fruits, vegetables, and herbs in addition to the consumption their use of vitamins and food supplements. The demographic details of the participants are also highlighted.

## Materials and methods

### Ethical approval

Conduction of the study has been approved by the Institutional Review Board (IRB) at the Applied Science Private University (study protocol number 2021-PHA-6). The research was performed following the ethical standards defined in the World Medical Association - Declaration of Helsinki guidelines (1964) and its later amendments (24).

### Study design and data collection

This cross-sectional questionnaire-based study was conducted in Iraq and Jordan with 1,083 participants among people of different age groups from March 2021 to April 2021. The study was done by voluntary participation using an online survey questionnaire, written in English and Arabic, but to prevent the linguistic barrier of the participants, the Arabic version of the questionnaire was used online. The questionnaire was developed using similar research articles previously published by Wazaify et al., 2011 and 2013 (25, 26). It was validated by asking the opinion of the members of the faculty council, who assessed and approved the questionnaire. The method used was based on the use of a semi-structured questionnaire trying to fulfil the aims of the study. Most of the participants, -those living in the cities - were recruited on-line while those from the countryside were interviewed by three co-authors of the study. The remaining while those from the country The submission of the completed questionnaires by the responders was considered consent to participate in the study. The participants were asked if they had changed their diet in various categories of plant foods or supplements and if the answer was yes, then they were asked to select from a predetermined list of choices in that category. The main themes addressed by the questionnaire are given in Table 1.

### Study limitations

The main limitation of the study was reaching people from the countryside due to the socio-economic conditions in both selected countries where access to the internet is limited, so there was a low response rate from the inhabitants of the rural areas. Also, findings cannot usually be generalized to the study population or community.

### Statistical analysis

All the data were entered and analyzed using SPSS 22 (SPSS, Inc., USA). The categorical variables were expressed as frequencies and percentages. The chi-square test and risk estimate analysis was used to analyze categorical variables. A simple logistic regression was used to identify any factors that may significantly affect the COVID-19 infection status among the study participants. All the factors with a *p*-value of < 0.25 from the previous process were introduced to multiple logistic regression. Nagelkerke R Square was used to determine the goodness of fit for the data. A *p*-value of < 0.05 was considered statistically significant for all statistical analyses. All the tests were two-tailed.

**Table 1.** Main themes addressed by the questionnaire used in the study

| | |
|---|---|
| Demographic data of the participants | Country, area of residence, gender, age group, and educational level |
| Have you increased your use of fruits during the COVID-19 pandemic? | Fixed list of 12 fruits: Lemons, oranges, dates, mangoes, papayas, pomegranates, strawberries, kiwis, apples, pineapples, watermelons, and melons |
| Have you increased your use of vegetables during the COVID-19 pandemic? | Fixed list of 12 vegetables: Chili and bell peppers, onions, garlic, carrots, broccoli, beans, peas, lentils, spinach, pumpkins, fennel, and tomatoes |
| Have you increased your use of grains and nuts during the COVID-19 pandemic? | Fixed list of 8 grains and nuts: Peanuts, walnuts, pistachios, cashews, raisins, and sunflower, pumpkin, and melon seeds |
| Have you increased your use of herbs and spices during the COVID-19 pandemic? | Fixed list of 15 herbs and spices: Ginger, turmeric, black pepper, black and green tea, chamomile, anise, rosella, mugwort, sage, cinnamon, thyme, mint, black lemon, and basil |
| Have you increased your use of oils and honey during the COVID-19 pandemic? | Fixed list of 3 oils and honey: Olive and sesame oils, fennel flower seed oil, and honey |
| Have you increased your use of vitamins and dietary supplements during the COVID-19 pandemic? | Fixed list of 7 vitamins/dietary supplements: Vitamins B complex, C, and D, zinc, omega 3, Echinacea, and ginseng |

## Results

### Sociodemographic characteristics of the participants

The analyzed responses included 1,083 participants. Figure 1 shows the distribution of participants by country and residence demonstrating 51% of the participants coming from Iraq and 49% from Jordan. Regardless of the country of origin, 87% of the participants were inhabitants of cities while only 13% of them were residing in the countryside.

The percentage of female participants (52%) was slightly higher than that of male participants (48 %) as seen in Figure 2. More than half of the participants held a bachelor's degree (53%) while 20% held a master's or PhD. Around three-fifths (60.5%) were within the age group 18-35 years. This high percentage of bachelor, master, and doctor degree holders among the survey participants is an indication that a big percentage of the responders were urban inhabitants. Figure 2.

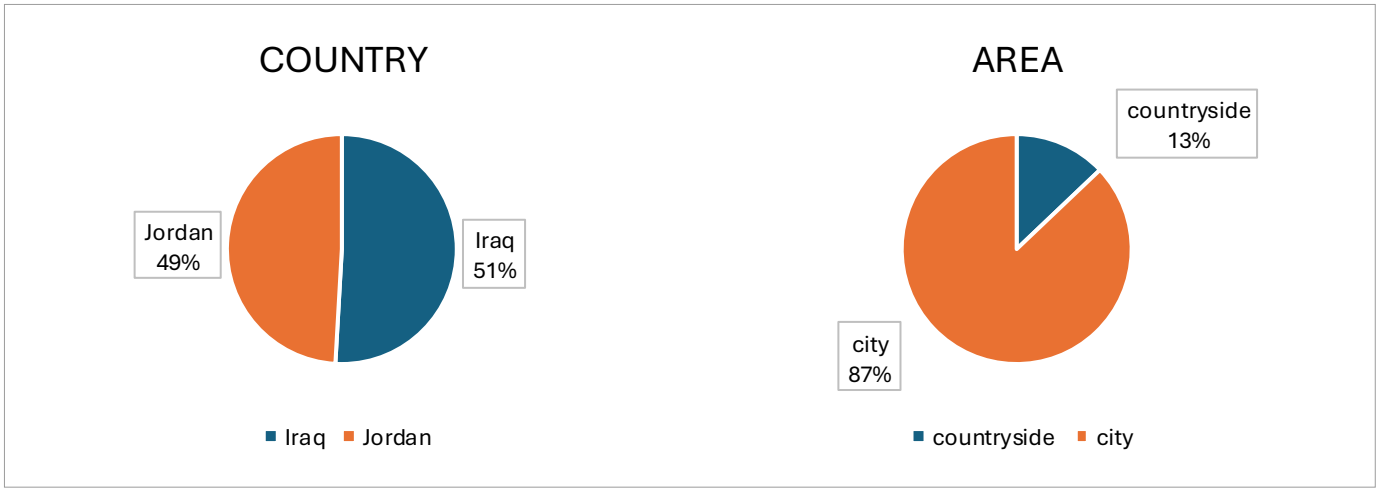


**Figure 1.** Country distribution of the participants and their geographic residential grouping. Association of the infection with the country (*p*-value is >0.05) and with area (*p*-value is <0.05).

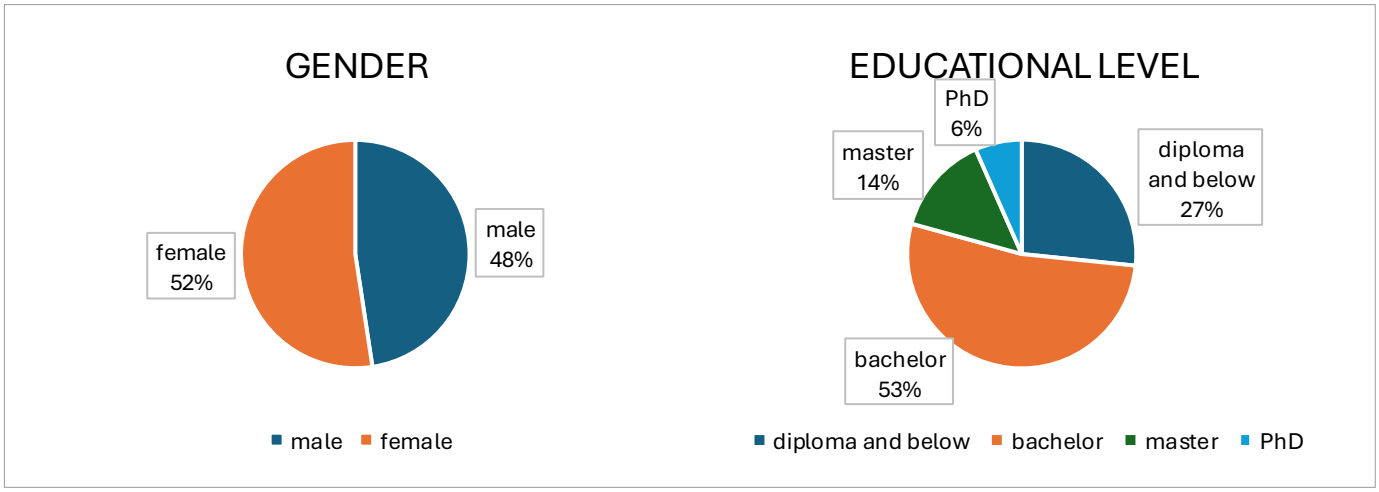


**Figure 2.** Gender and educational level of the participants. Association of the infection with the gender ($p$-value is >0.05) and with the educational level ($p$-value is >0.05).

### Prevalence of COVID-19 among the participants and their food consumption habits

Table 2 summarizes the effect of the COVID-19 global pandemic on Jordanian and Iraqi awareness of the importance of their daily diet. A total of 160 participants from Jordan and 152 participants from Iraq were infected with the virus SARS-CoV2, which accounted for 28.8% of the respondents. Out of 1,083 participants, most of the respondents increased their fruit consumption (71.7%), followed by vitamins and dietary supplements (67.7%) and vegetables (67.4%). Also. 53.7% of participants increased their consumption of grains and nuts, 50.1% honey and oils, and 50.0% herbs and spices Table 2.

### COVID-19 pandemic and frequency of using fruits and vegetables

The percentages of the different types of fruits preferred by the participants, are given in Figure 3. Among the suggested 12 different fruits, the citrus fruits oranges and lemons scored the highest percentages with 88.9% and 79.1%, respectively. In Jordan and Iraq, lemons and oranges are available throughout the year at suitable prices. The benefits of citrus fruits, especially sweet oranges and lemons which have a rich content of vitamins (vitamin C, vitamin B., thiamin, niacin, folate and carotenoids), minerals (potassium, calcium, phosphorus, magnesium, and copper) and diverse plant secondary metabolites (flavonoids, terpenes, and phenolic compounds) are well accepted in the management of the common cold, inflammation, and infections (28, 29). Slightly less than 50% of the respondents preferred to use apples to increase their immunity. Pomegranates, praised for their antioxidant potential, together with nutritious dates were mentioned by 32.3% and 32.0% of participants, respectively.

Many vegetables used in a daily diet are rich in sources of vitamins, flavonoids, and other aromatic phenols with potent antioxidant, antimicrobial, and anticancer properties. Fourteen different vegetables were included in the list of the present study Figure 4. The three most used vegetables in the present study were onions (78.8%), bell pepper (63.4%), and garlic (58.6%).

### COVID-19 pandemic and frequency of using vitamins and dietary supplements

In the present questionnaire, the vitamin supplements listed were vitamin B complex and the vitamins C and D, together with the omega 3 essential fatty acids and zinc, and the two widely used plant originated products listed were ginseng and Echinacea Figure 5. Among this group, more than 60% of the participants sought an immunity boost by taking vitamins C (91.0%) and D (73.9%) and the mineral zinc (72.5%) which are sold in pharmacies of both countries as over the counter (OTC) preparations at reasonable prices. Ginseng and echinacea, were the choice of a tiny minority of the participants (2.3% and 1.8%, respectively).

### COVID-19 pandemic and frequency of using honey and oils

Half of the participants (50%) revealed that they had increased their consumption of oils and honey during the COVID-19 pandemic Figure 6.

### COVID-19 pandemic and frequency of using herbs and spices

Half of the participants of the present study (542 participants) reported that they had increased their consumption of herbs and spices during the COVID-19 pandemic Figure 7. Among the listed herbs and spices, ginger, which is a cooking spice, condiment, and herbal remedy, was mentioned as the most used botanical (60.5%). In both countries, the herbs that are very popular are thyme, anise, and mint, which are used as hot beverages consumed daily as well as used as a flavoring agent for many foods, but these did not reach even a 50% increase during the pandemic.

### COVID-19 pandemic and frequency of using grains and nuts

A total of 582 respondents (53.7%) had increased their grains and nuts consumption during the COVID-19 pandemic. Walnut (*Juglans regia* L.) consumption increased by 60.7% Figure 8.

**Table 2.** The effect of the COVID-19 global pandemic on Jordanian and Iraqi awareness of the importance of their daily diet and the association between the infection and increased consumption COVID-19 pandemic and frequency of using fruits and vegetables

| | Yes (%) | No (%) | Chi Square $p$ value |
|---|---|---|---|
| Have you increased your use of fruits during the COVID-19 pandemic? | 776 (71.7) | 307 (28.3) | < 0.05 |
| Have you increased your use of vegetables during the COVID-19 pandemic? | 730 (67.4) | 353 (32.6) | < 0.05 |
| Have you increased your use of grains and nuts during the COVID-19 pandemic? | 582 (53.7) | 501 (46.3) | < 0.05 |
| Have you increased your use of herbs and spices during the COVID-19 pandemic? | 542 (50.0) | 541 (50.0) | < 0.05 |
| Have you increased your use of oils and honey during the COVID-19 pandemic? | 542 (50.1) | 540 (49.9) | > 0.05 |
| Have you increased your use of vitamins and dietary supplements during the COVID-19 pandemic? | 733 (67.7) | 350 (32.3) | < 0.05 |

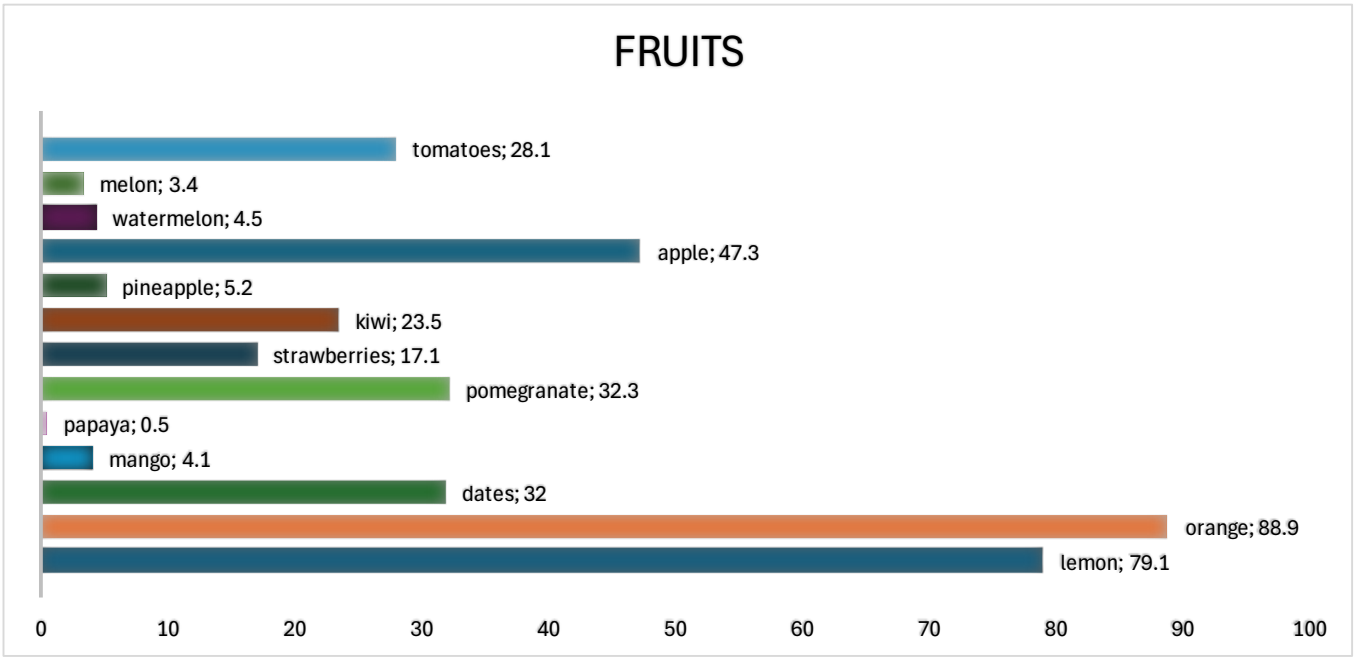


**Figure 3.** Frequency (%) of using fruits during COVID-19 pandemic

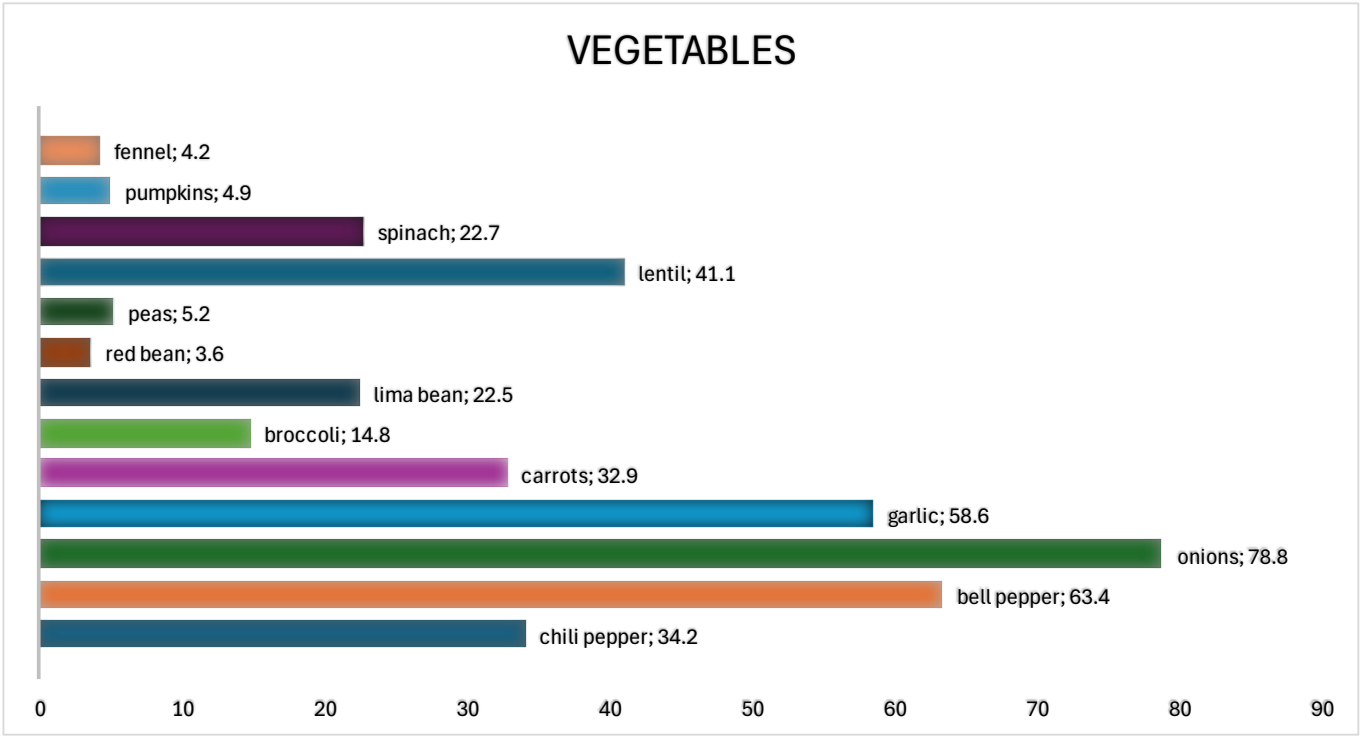


**Figure 4.** Frequency (%) of using vegetables during COVID-19 pandemic

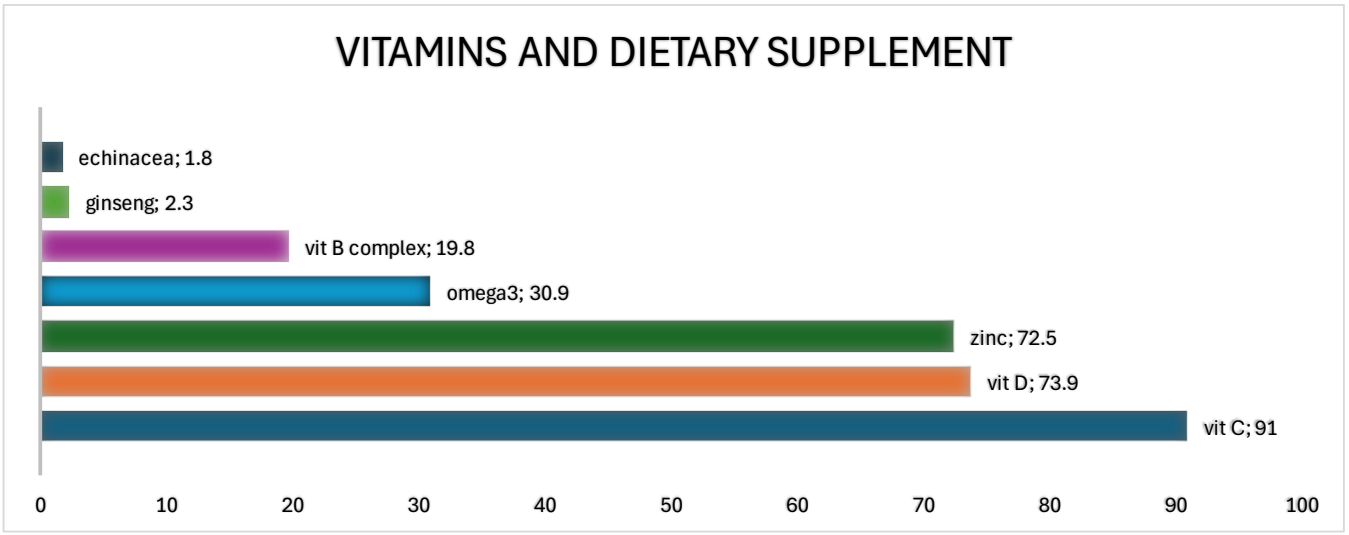


**Figure 5.** Frequency (%) of using vitamins and dietary supplements during COVID-19 pandemic

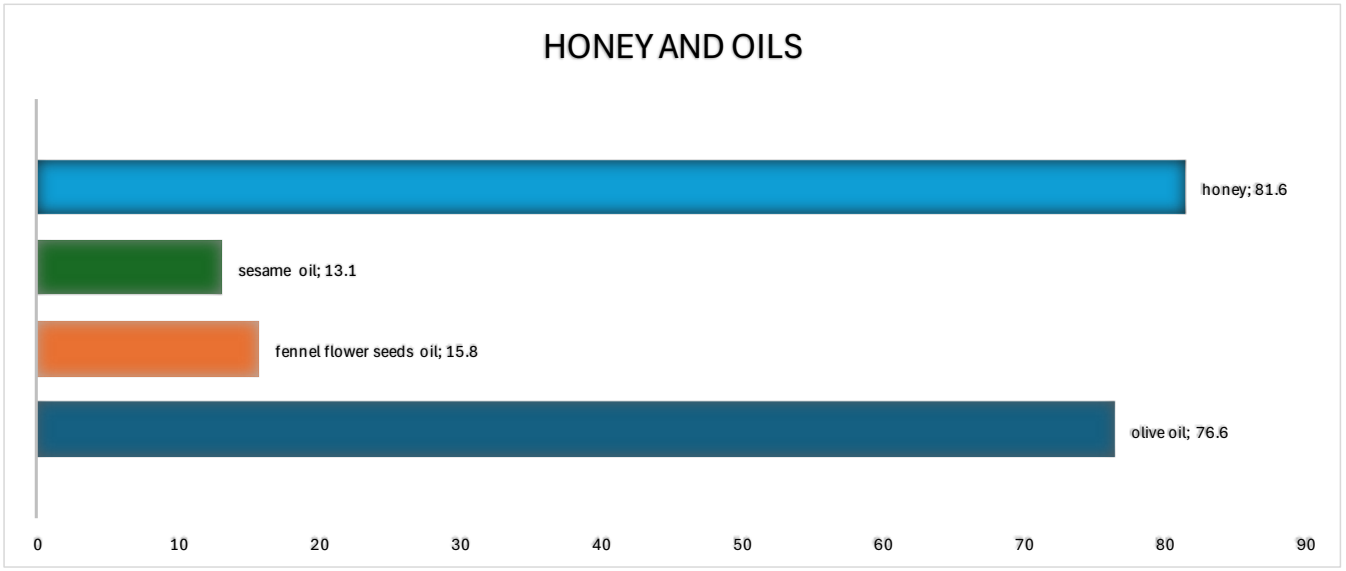


**Figure 6.** Frequency (%) of using honey and oils during COVID-19 pandemic

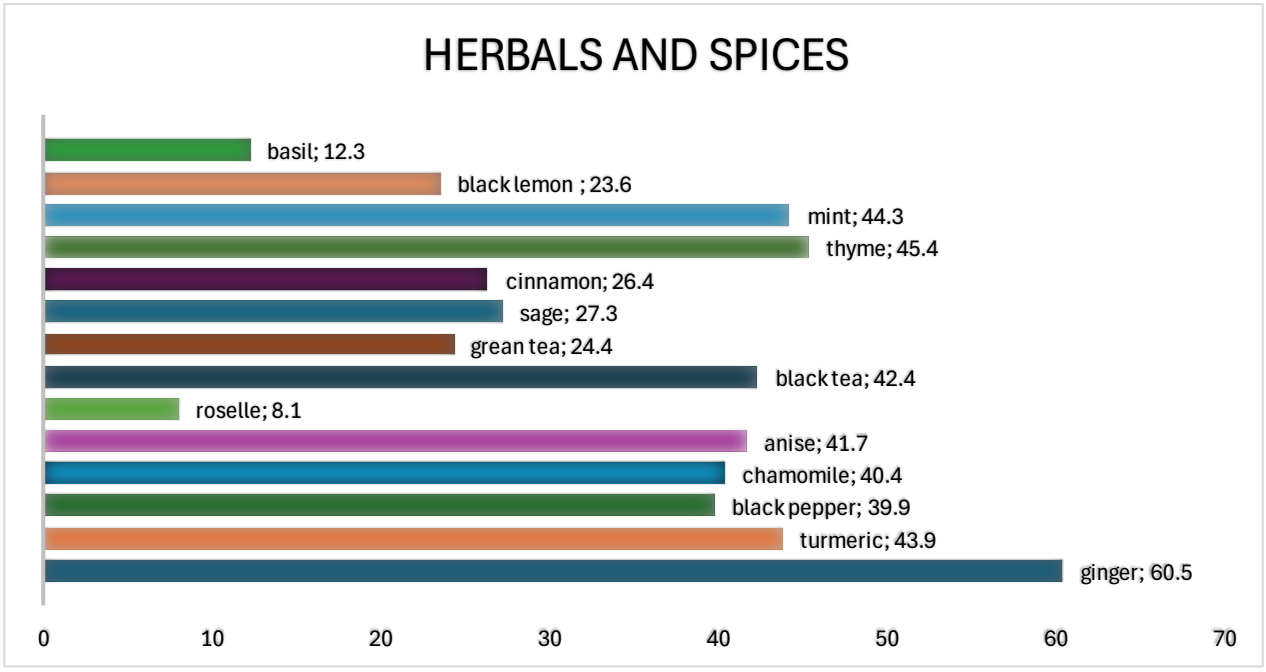


**Figure 7.** Frequency (%) of using herbs and spices during COVID-19 pandemic

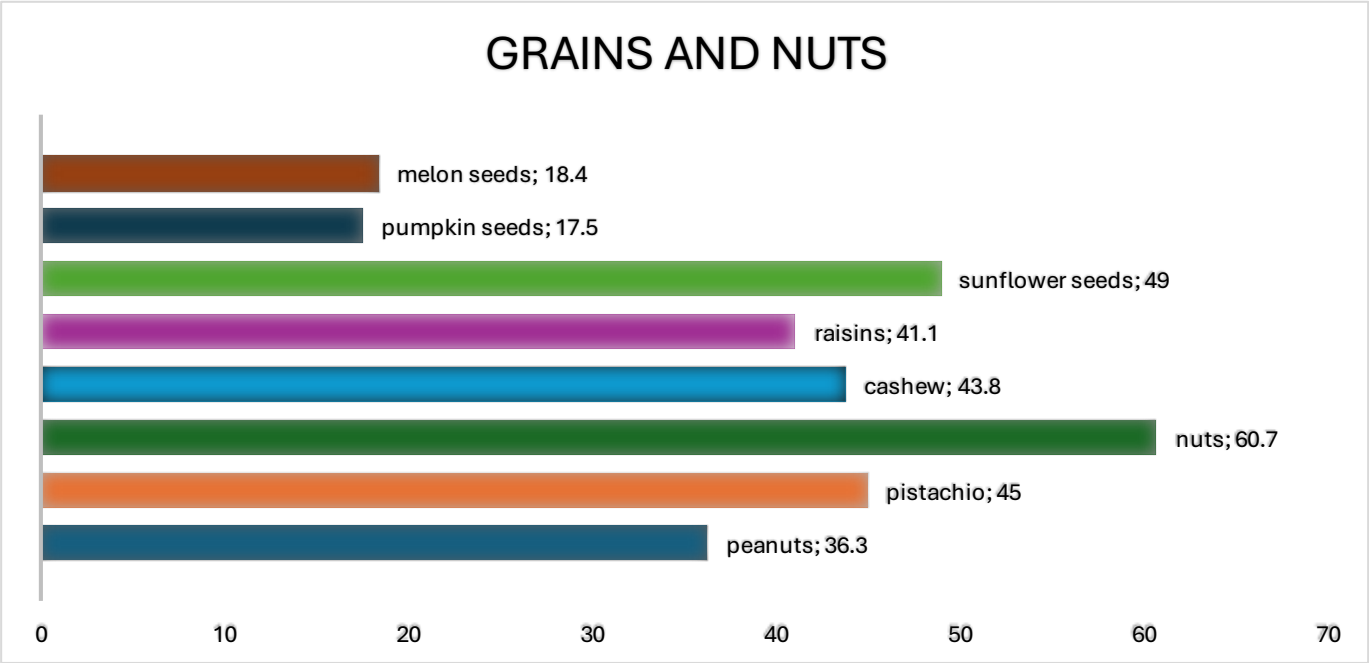


**Figure 8.** Frequency (%) of using grains and nuts during COVID-19 pandemic

## Discussion

### Food consumption habits and prevalence of COVID-19 among the participants

Nutrition is one of the most important determinants of health, and diets rich in plant foods (fruits and vegetables and their oils) may prevent or alleviate the symptoms, or in a limited manner even cure, non-communicable diseases, infectious and cardiovascular diseases, and cancers due to the health-promoting properties of the thousands of phyto-constituents with multiple biological propensities (27).

### COVID-19 pandemic and frequency of using fruits and vegetables

In Jordan and Iraq, lemons and oranges are available throughout the year at suitable prices. The benefits of citrus fruits, especially sweet oranges and lemons which have a rich content of vitamins (vitamin C, vitamin B6, thiamin, niacin, folate and carotenoids), minerals (potassium, calcium, phosphorus, magnesium, and copper) and diverse plant secondary metabolites (flavonoids, terpenes, and phenolic compounds) are well accepted in the management of the common cold, inflammation, and infections (28,29).

Many vegetables used in a daily diet are rich in sources of vitamins, flavonoids, and other aromatic phenols with potent antioxidant, antimicrobial, and anticancer properties. Both *Allium cepa* (onion) and *A. sativum* (garlic) are classified as culinary and medicinal plants belonging to the family Liliaceae and are cultivated throughout the world. The organosulfurous compounds of garlic, such as diallyl sulphate, alliin, ajoene, and allicin together with several enzymes, amino acids, and minerals such as selenium are responsible for its medicinal effects. Garlic is one of nature's wonderful plants with healing power having multiple potent biological activities, including antibacterial, antifungal, antiviral, antiparasitic, and anticancer activities (30, 31). A wide range of bioactive phytochemicals including phenolic acids, flavonoids (quercetin and kaempferol), anthocyanins, and organosulfur compounds have also been identified in onions. Since ancient times onions have been used in (34, 35).

the traditional medicines of different cultures in the management of various ailments as well as the promotion of better health. Based on numerous *in vitro* and *in vivo* studies, numerous pharmacological properties including antimicrobial, antiviral, antioxidant, analgesic, anti-inflammatory, anti-diabetic, hypolipidemic, anti-hypertensive, and immunoprotective effects are reported for onions (32, 33).

Bell pepper (*Capsicum annuum*) is a well-known food ingredient throughout the Mediterranean countries, but it is also used in traditional medicine especially treating the symptoms of the gastrointestinal tract such as stomachache, diarrhea, and dysentery. Capsicums are also used in the treatment of toothache, parasitic infections, coughs, wound healing, sore throat, and rheumatism, with antimicrobial, antiseptic, anticancer, counterirritant, appetite stimulator, antioxidant, and immunomodulatory activities. Bell pepper is a good source of provitamin A, vitamins E and C, carotenoids, and phenolic compounds such as capsaicinoids, flavonoids, and minerals (iron, zinc, calcium, potassium, and magnesium). All these compounds are associated with their antioxidant as well as other biological activities and regarded as a rich source of vitamins for the strengthening of the immune system

### COVID-19 pandemic and frequency of using vitamins and dietary supplements

Several studies demonstrated the essential role and life-saving effects of intravenous administered vitamin C, even as a monotherapy in the management of COVID-19 (36-39). In addition, since vitamin D has anti-inflammatory and immunomodulatory properties it can offer potential benefits at different stages of COVID-19. The effect of vitamin D supplementation on the prevention of respiratory infections and their complications has been demonstrated by clinical studies (40-42). Additionally, researchers have discussed and evaluated that vitamin D supplementation is considered as a preventive or therapeutic agent for COVID-19 (43-45). On the other hand, both botanicals, namely ginseng and echinacea, although widely used in different traditional medicines and scientifically proven through *in vitro*, *in vivo*, and clinical research as medicine for various diseases including immune diseases, were not favored by the Iraqi and Jordanian participants (46-48).

### COVID-19 pandemic and frequency of using honey and oils

Honey has been used for medicinal purposes since the time of the Egyptian civilization by the ancient Greeks and Egyptians. In the predominantly Islamic countries of the Middle East, honey is regarded as an all-around remedy for the treatment of multiple conditions of human ailments, internally and externally. As a result of numerous studies on the health benefits of honey, it is incorporated as an ingredient in nutraceuticals and functional foods (49-50).

The basic oil of the Mediterranean diet is olive oil, obtained from the fruits of *Olea europea*, indigenous to Palestine and neighboring countries. Olive oil has nutritional value along with broad spectrum health-promoting and therapeutic benefits based on various scientific studies. The beneficial effects of the oil are primarily due to the bioactive polyphenols, involved in antioxidant, anti-inflammatory, antiallergic, anti-atherogenic, anti-thrombotic, and anti-mutagenic, antidiabetic effects. Several studies have underlined the role of olive and olive oil fractions on the immune system and several immune mediated diseases (51, 52).

### COVID-19 pandemic and frequency of using herbs and spices

In Jordan and Iraq, like in many countries in the Middle East, preparing spicy food and seeking curative benefits from traditional medicine, using primarily herbs, is a common practice (53,54). Ginger, the most used spice, is considered a safe herbal medicine, rich in phenolic substances and terpene compounds with only few and insignificant adverse/side effects. Investigations of many researchers revealed that ginger has immunomodulatory, anti-tumorigenic, anti-inflammatory, anti-apoptotic, anti-hyperglycemic, anti-lipidemic, and anti-emetic actions. Ginger is a strong antioxidant substance and may either mitigate or prevent the generation of free radicals (55, 56).

### COVID-19 pandemic and frequency of using grains and nuts

Nuts, which are rich in macro and micro-nutrients, minerals, and bioactive phytochemicals, have been used traditionally for improving immunity, digestion, wound healing, heart diseases, and circulation and as an analgesic and neuroprotective agent. They are potent antioxidants (57, 58). Walnuts are among the most widely consumed commercially grown tree nuts in the world, rich in polyunsaturated fatty acids and phenolic compounds (phenolic acids, flavonoids, and tannins) with potent antioxidant capacities. Based on the prevalence of these potent bioactive substances, regular consumption of walnuts can accomplish multiple health benefits (59, 60).

Finally, to validate the findings of the present study a further literature survey was carried out. In a comprehensive review article including reports published from eleven countries Arora et al, (2023) revealed the increasing tendency in using herbal product, honey, vitamins and dietary supplements for prevention of COVID-19 infection and for the strengthening of the immune system (61). Recently, Chinyanga et al. (2024) have found that during COVID-19 peak and post- peak periods greater amounts of fresh fruit and vegetables were consumed in USA as in Jordan and in Iraq (62). Contrary, researchers from Saudi Arabia reported that for most of the participants COVID-19 did not influence their consumption patterns regarding the vitamins and dietary supplements positively (63).

## Conclusion

In conclusion, the present survey showed that the inhabitants of both countries are aware of the fact that different plant foods (fruits, vegetables, nuts, herbs, and spices) and other edible products related to plant foods (honey) or derived from plant foods (olive oil) provide desirable health benefits during the COVID-19 pandemic. Also, supportive treatment, especially supplementation with vitamin C, has been sought by the participants for protecting themselves from COVID-19. Based on the findings of the current study, public health care providers should encourage the community to always maintain their healthy eating habits, and not only during pandemics.

### Authors' contribution

A. Khalid: design of the study and methodology; H. Rashid and A. Munaim: statistical analysis and data curation; M. Alsafi: data curation and validation; F.U. Afifi: design of the study, supervision, and writing (review and editing). All authors read and approved the final manuscript.

### Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

Data will be available upon request


### Funding

Not applicable

### Acknowledgements

The authors would like to thank all persons who accepted to participate in this online survey.


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