Use of vitamin/zinc supplements, medicinal plants, and immune boosting drinks during COVID-19 pandemic: A pilot study from Benha city, Egypt

Omar F. Khabour a,*, Salwa F.M. Hassanein b

a Department of Medical Laboratory Sciences, Jordan University of Science and Technology, Irbid 22110, Jordan
b Department of Food Science and Technology, Ain Shams University, Cairo, Egypt

ARTICLE INFO
Keywords:
COVID-19
Egypt
Vitamin
Zinc
Honey
Garlic
Immune system
Medicinal plants

ABSTRACT

Background: The COVID-19 infection is characterized by a wide spectrum of severity that ranges from mild to severe lethal symptoms. The optimal status of vitamins and minerals in the body is important to maintain proper immune response to overcome infections including COVID-19. Certain foods and medicinal plants have been shown to boost the immune system.

Objectives: In the current study, the use of vitamin and zinc supplements, medicinal plants, honey, garlic, and immune-boosting drinks among Egyptian living in Benha city were investigated during the corona pandemic.

Methods: An online questionnaire was distributed through Google forms. A total of 301 adult participants (age range: 18–82) from Benha city, Egypt were included in the study. The Chi2 goodness of fit test was used to determine the differences in the distribution of the participant responses.

Results: The use of vitamin C and D were reported by 27% and 17.7% of participants. About one-third of participants reported the use of immune-boosting drinks, honey, and garlic during the pandemic to strengthen the body immunity. The use of Zingiber officinale and Curcuma longa was reported by 47.2% and 31.6% respectively. Concerning zinc supplements, only 5.6% of the sample reported using it during the pandemic. The use of examined nutrients was found to be associated with age (P < 0.05) and the fear score from the virus (P < 0.05), but not with other factors such as sex, income, and educational level.

Conclusion: The uses of supplements, medicinal plants, and immune-boosting drinks to strengthen the immune system during the pandemic were common among the participants. The present findings may help comprehend some health practices related to the COVID-19 pandemic that might be considered by health policymakers.

1. Introduction

COVID-19 belongs to the corona group of enveloped viruses with a single-stranded RNA genome (Esakandari et al., 2020). Coronaviruses can infect mammals from bats to humans and usually cause respiratory illnesses (Muniyappa and Gubbi, 2020). While some coronaviruses have caused devastating epidemics such as SARS-1 COV and MERS-COV, the majority infect the upper respiratory tract and leads to light to moderate symptoms similar to the common cold (García, 2020).

The immune system is the major protective system of the body, which is responsible for response against foreign bodies such as viruses. There are two types of immune responses, the innate immune response, which includes a group of cells protecting the body against any foreign invading material engulfing and releasing chemicals that ultimately kills the foreign agent (Thaiss et al., 2016). The acquired immunity is the other type of immune response. It is mostly concerned with detailed and more specific action against invading microbes (Lovely and Sen, 2016).

Malnutrition is the most common cause of immunodeficiency by interfering with cell-mediated immune responses, functions of phagocytes, cytokine synthesis, and immunoglobulin A secretion (Galmés and Serra, 2020; Iddir et al., 2020). Deficiency of a single nutrient such as zinc, selenium, manganese, vitamins, and folic acid could significantly alter the immune response to infections (Ali, 2020; Galmés and Serra, 2020; Zemb et al., 2020). Thus, nutritional status, as a modifiable factor, plays a key role in the functioning and maintaining of the immune system integrity.

Current literature identified risk factors that contribute to the development of the severe form of COVID-19 infection. These factors include malnutrition such as vitamin deficiency, and having chronic conditions such as diabetes mellitus, pulmonary dysfunction, heart
In Italy, the majority of study participants believed that strengthening of the immune system is important to reduce the risk of COVID-19 complications of the infection (Iddir et al., 2020). Therefore, nutritional support is highlighted as an essential part of the management of COVID-19 infection. On the other hand, maintaining good nutritional status is suggested as a useful strategy to prevent/avoid complications of the infection (Iddir et al., 2020).

In a USA study, a slight increase in the use of supplements including zinc and vitamin C was reported among older adults (Brown et al., 2020). In Italy, the majority of study participants believed that strengthening immune defenses through nutrition elements that enhance the function of the immune system is important to reduce the risk of COVID-19 infection (Savarese et al., 2020). In a survey study that includes several countries, increased consumption of ginger, garlic, onion, turmeric, and lemon during the pandemic was reported (Pieroni et al., 2020). However, the use of supplements and foods that boost the immune system was not yet investigated in Egypt. Therefore, in this study, the use of supplements and foods that boost the immune response among Egyptians was examined by taking Benha city as an example. The study highlights the importance of using available nutrients to maintain the integrity of the immune system and avoid complications of COVID-19 infection.

2. Method

2.1. Subjects

In the current study, Egyptian adults (age: 18+) from both sexes and living in Benha city, were invited to participate. The population of Benha was 166,000 in 2012. The study is a cross-sectional survey conducted during the period from April to June of 2020. The study was approved by the Ethical Committee of Scientific Research at Ein Shams University. Consent of the participants was taken electronically before the participants started filling the questionnaire. The study objectives, procedures, and voluntary participation were described in the cover webpage of the questionnaire. The questionnaire was anonymous and thus the privacy of the participants was maintained.

2.2. Questionnaire

An electronic survey form was developed by the researchers to cover the aims of the study. The survey consisted of four domains. The first domain covered demographics such as age, sex, education, income, and health status. The second domain asked questions about the use of the supplement (vitamins, minerals, and immune-boosting) during the COVID-19 pandemic. The selection of such supplements was based on previous studies that showed their beneficial effects in the management/prevention of COVID-19 infection complications (Ali, 2020; Rhodes et al., 2020; Weir et al., 2020). The third domain asked questions about the consumption of drinks and foods known to enhance the functions of the immune system and are available and affordable by the studied population. Immune boosting drinks include the use of any of the following drinks during the pandemic to enhance immunity: green tea, star anise, mint, marjoram, hibiscus, orange juice, and lemon juice. Foods include garlic and honey (Pieroni et al., 2020). The last domain used a validated fear scale (Ahorsu et al., 2020) to measure the fear of the participants of COVID-19 infection. The first draft of the questionnaire was content, and face validated by three expert colleagues in the fields of public health, nutrition, and pharmacology/medicinal plants. Then, the revised draft of the questionnaire was pilot tested online with 15 subjects from both sexes to provide their advice regarding the clarity and comprehensibility of the different items. Feedback obtained from the pilot testing was incorporated in the final form of the questionnaire. The questionnaire was distributed anonymously and electronically via social media groups such as Facebook and Whatsapp. The anonymity was insured by avoiding sharing the link with particular individuals. The questionnaire did not ask questions that might identify the participants. All questions were optional and participants had the choice to skip any question they don’t like to answer. The English translation of the questionnaire is provided as supplementary material, whereas the Arabic version is available upon request.

2.3. Fear scale

A fear of COVID-19 scale was used in the study as described previously (Ahorsu et al., 2020). The scale is a valid instrument that assesses fear of COVID-19 among the general populations. It is based on a five-item Likert type scale. The answers included “strongly disagree,” “disagree,” “neither agree nor disagree,” “agree,” and “strongly agree.” The scores range from 1 for “strongly disagree,” to 5 for “strongly agree.” The fear score is calculated by totaling the scores of the seven items (ranging from 7 to 35). Fear of COVID-19 is proportionate with the total score.

2.4. Statistics

Data were obtained from Google forms as an EXCEL spreadsheet. Data were then exported into the SPSS statistical program (version 21). The Chi² goodness of fit test was used to determine the differences in the distribution of the participant responses. The G*Power program (version 3.1.92) was used to compute the sample size. A significance level of 0.05, a power of 0.80, with an effect size of 0.15 resulting in a minimum number of subjects being 270. Cross-tabulation was used to link the participant responses to demographics (age, sex, income, and education). For statistical significance, α was set apriori at 0.05.

3. Results

A total of 301 participants completed the questionnaire. The mean age of participants was 36.8 ± 14.4 years. About 20% of the sample were 50 or more years old (Table 1). Females represent 64.5% and the majority (59.8%) had a bachelor's degree (Table 1). About one third had chronic diseases such as diabetes and cardiovascular diseases. The majority (61.8%) were of low income (<10,000 Egyptian pounds, Table 1). The mean fear scale from COVID-19 was 23.66 ± 5.32 out of 35. Table 2 showed vitamin use among the participants. The percentages of users were 27%, 17.7%, 13%, and 13% for vitamins C, D, A, and B respectively. Vitamin use was strongly associated with age (P < 0.05, Table 2). For example, vitamin C use was higher among ≥50 years old participants (45.8%) compared to younger ones (19.7–25.0%, P < 0.001). Similarly, vitamin use was strongly associated with fear scores as the percentage of users increased with an increase in the fear score (P < 0.05, Table 2). Concerning other factors such as sex, education, income, and the presence of chronic diseases, no or weak associations were observed (Table 2).

Table 3 showed the use of immune-boosting nutrients to strengthen the immune system. About 39.3%, 32.2%, and 37.2% reported the use of immune-boosting drinks, honey, and garlic respectively. With respect to zinc supplements, only 5.6% of the sample reported using it during the COVID-19 pandemic. The use of immune-boosting drinks was found to be associated with age, income, presence of chronic diseases, and fear score (P < 0.05). The use of honey was found to be associated with age and fear score (P < 0.05). The use of garlic was found to be associated with age only (P < 0.05). None of the examined parameters were found to be associated with zinc use (P > 0.05, Table 3).

Concerning medicinal plants (Table 4), high use of Zingiber officinale (47.2%) and Curcuma longa (31.6%) was reported. On the other hand,
low use of most examined medicinal plants was reported and they include *Origanum majorana* (7.7%), *Carum carvi* (8.6%), *Trigonella foenum-graecum* (13.0%), *Salvia rosmarinus* (13.6%), and *Ocimum basilicum* (10.0%). Use of *Zingiber officinale* and *Curcuma longa* during COVID-19 was found to be associated with age and fear score. The rest of investigated medicinal plants were not associated with any of study variables.

### Table 1. Demographics of participants.

| Parameter                   | Sub-group | N (%)* |
|-----------------------------|-----------|--------|
| **Mean age (years ±SD)**    |           | 36.8 ± 14.4 |
| **Age groups**              |           |         |
| 18–29                       | 124 (41.2) |        |
| 30–49                       | 117 (38.9) |        |
| ≥50                         | 60 (19.9)  |        |
| **Sex**                     |           |         |
| Male                        | 124 (41.2) |        |
| Female                      | 117 (38.9) |        |
| **Education**               |           |         |
| <High school                | 64 (21.3)  |        |
| Bachelor                    | 180 (59.8) |        |
| Master/PhD                  | 55 (18.3)  |        |
| **Income (Egyptian pound)** |           |         |
| <10000                      | 187 (61.8) |        |
| 10,000–49,000               | 89 (29.6)  |        |
| ≥50,000                     | 19 (6.3)   |        |
| **Chronic diseases**        |           |         |
| Yes                         | 88 (29.6)  |        |
| No                          | 212 (70.4) |        |
| **Fear from COVID-19**      | Mean ± SD | 23.66 ± 5.32 |
| **Mean age**                | Mean ± SD | 36.86 ± 14.4 |

* N(%): Number (percentage).
* SD: Standard deviation.

### Table 2. Vitamin use during COVID-19 pandemic.

| Parameter                      | Vitamin A | Vitamin B complex | Vitamin C | Vitamin D |
|--------------------------------|-----------|-------------------|-----------|-----------|
| **Total**                      | Yes: N(%) | 39 (13)           | 39(13)    | 81(27.0)  |
|                                | No: N(%)  | 261(87)           | 261(87)   | 219(73.0) |
|                                | P value   | 0.447             | 0.000     | 0.001     |
| **Age groups**                 |           |                   |           |           |
| 18–29                          | 10(3.4)   | 10(3.4)           | 11(3.9)   | 1(0.6)    |
| 30–49                          | 11(3.4)   | 11(3.4)           | 11(3.9)   | 1(0.6)    |
| ≥50                            | 7(2.5)    | 7(2.5)            | 7(2.5)    | 0(0.0)    |
| **Sex**                        |           |                   |           |           |
| Male                           | 12(4.2)   | 12(4.2)           | 12(4.2)   | 1(0.6)    |
| Female                         | 26(8.7)   | 26(8.7)           | 26(8.7)   | 25(8.7)   |
| **Education**                  |           |                   |           |           |
| <High school                   | 10(3.4)   | 10(3.4)           | 11(3.9)   | 1(0.6)    |
| Bachelor                       | 11(3.4)   | 11(3.4)           | 11(3.9)   | 1(0.6)    |
| Master/PhD                     | 7(2.5)    | 7(2.5)            | 7(2.5)    | 0(0.0)    |
| **Income (Egyptian pound)**    |           |                   |           |           |
| <10000                         | 187 (61.8)| 187 (61.8)        | 187 (61.8)| 187 (61.8)|
| 10,000–49,000                  | 89 (29.6) | 89 (29.6)         | 89 (29.6) | 89 (29.6) |
| ≥50,000                        | 19 (6.3)  | 19 (6.3)          | 19 (6.3)  | 19 (6.3)  |
| **Chronic diseases**           |           |                   |           |           |
| Yes                            | 88 (29.6) |                   |           |           |
| No                             | 212 (70.4)|                   |           |           |
| **Fear Score**                 | Mean ± SD | 23.66 ± 5.32      |           |           |
| **Mean age**                   | Mean ± SD | 36.86 ± 14.4      |           |           |

* N(%): Number (percentage).
* SD: Standard deviation.

4. Discussion

In the current study, the use of vitamin supplements, immune-boosting foods, and medicinal plants during the COVID-19 pandemic was investigated. Relatively, higher use of vitamin C and D, and the immune system boosting drinks, honey, and garlic were reported. In addition, in about one-third of participants, the use of *Zingiber officinale* and *Curcuma longa* was also reported.

One of the characteristics of the COVID-19 infection is the wide spectrum of severity that ranges from no (asymptomatic carriers) into severe lethal symptoms (Esakandari et al., 2020; Harapan et al., 2020). Different factors have been shown to contribute to such a wide range and include age, health status, and immune response (García, 2020; Paces et al., 2020). The severity of the infection is higher in the elderly compared to young and children (Ladvigsson, 2020; Nikolich-Zugich et al., 2020; She and Liu, 2020). The presence of chronic conditions significantly increases the risk of developing severe forms of the infection (Huang et al., 2020; Muniyappa and Gubbi, 2020). Moreover, deficiency in some nutrients such as vitamins and minerals can modulate response to the virus infection (Carr, 2020; Weir et al., 2020).

In the current study, the use of vitamin C and D were reported by 27% and 17.7% of participants during the pandemic, whereas less increase in the use of other vitamins was indicated. Using Google Trends, the interest in immune-boosting agents, vitamin and mineral supplements, and some foods (such as garlic and ginger) was increased during the COVID-19 pandemic (Hamulka et al., 2020). In a European study, the belief in the importance of dietary supplements in overcoming infections became significantly more pronounced during the pandemic (Karbowink et al., 2020). In a USA study, a slight increase in the use of supplements including zinc and vitamin C was reported in a study that was conducted among older adults (Brown et al., 2020). An association between vitamin D blood level and immune response and the subsequent enhanced risk of severe lethal symptoms (Esakandari et al., 2020; Harapan et al., 2020). The presence of chronic conditions significantly increases the risk of developing severe forms of the infection (Huang et al., 2020; Muniyappa and Gubbi, 2020). Moreover, deficiency in some nutrients such as vitamins and minerals can modulate response to the virus infection (Carr, 2020; Weir et al., 2020).
pneumonia and coronavirus upper respiratory tract infection is well documented (Ali, 2020; Weir et al., 2020). Besides, vitamin D supplements decrease acute respiratory infections as indicated by randomized controlled trial studies (Zemb et al., 2020). Vitamin D might modulate the inflammatory response and viral infection through increasing angiotensin II hydrolysis via shifting the ratio of angiotensin-converting enzyme 2 (ACE2) to ACE (Rhodes et al., 2020). Vitamin C has strong antioxidant, anti-inflammatory, and antiviral properties (Boretti and Fattaccia, 2017). Vitamin C might modulate the inflammatory response and viral infection through increasing inflammatory, and antiviral properties (Boretti and Fattaccia, 2017). Vitamin C might modulate the inflammatory response and viral infection through increasing inflammatory, and antiviral properties (Boretti and Fattaccia, 2017).

| Table 3. Use of Immune boosters during COVID-19 pandemic. |
|----------------------------------------------------------|
| **Parameter** | **Immune system boosting drinks** | **Immune system boosting: honey** | **Immune system boosting: Garlic** | **Zinc supplements** |
| | Yes: N(%) | No: N(%) | 𝑃 value | Yes: N(%) | No: N(%) | 𝑃 value | Yes: N(%) | No: N(%) | 𝑃 value |
| Total | 118(39.3) | 182(60.7) | 97(32.2) | 204(67.8) | 112(37.2) | 189(62.8) | 17(5.6) | 283(94.4) |
| Age groups | | | | | | | | |
| 18–29 | 57(46.0) | 67(54.0) | 32(25.8) | 92(74.2) | 40(32.3) | 84(67.7) | 7(5.6) | 117(94.4) | 0.343 |
| 30–49 | 48(41.0) | 69(59.0) | 26(22.2) | 91(77.8) | 42(35.9) | 75(64.1) | 5(4.3) | 112(95.7) |
| ≥50 | 14(23.3) | 46(76.7) | 39(65.0) | 21(35.0) | 30(50.0) | 30(50.0) | 5(8.5) | 54(91.5) |
| Sex | | | | | | | | |
| Male | 41(39.4) | 63(60.6) | 0.967 | 40(38.5) | 64(61.5) | 0.060 | 38(36.5) | 66(63.5) | 0.477 |
| Female | 76(39.2) | 118(60.8) | 0.041 | 64(38.5) | 64(61.5) | 0.410 | 75(39.9) | 68(60.1) | 0.037 |
| Education | | | | | | | | |
| <4th | 14(31.8) | 30(68.2) | 0.011 | 22(34.3) | 43(65.7) | 0.000 | 26(34.2) | 54(65.8) | 0.018 |
| ≥4th | 36(45.6) | 43(54.4) | 0.025 | 54(38.9) | 84(61.1) | 0.000 | 39(43.1) | 53(56.9) | 0.000 |
| Chronic diseases | | | | | | | | |
| Yes | 91(42.9) | 121(57.1) | 0.051 | 76(40.9) | 110(59.1) | 0.010 | 129(57.1) | 90(42.9) | 0.056 |
| No | 28(31.5) | 61(68.5) | 0.051 | 67(34.7) | 133(65.3) | 0.000 | 40(32.3) | 84(67.7) | 0.018 |
| Fear Score | | | | | | | | |
| ≤3.0 | 13(65.0) | 7(35.0) | 0.011 | 24(34.3) | 45(65.7) | 0.000 | 26(34.2) | 54(65.8) | 0.018 |
| >3.0 | 50(36.0) | 90(64.0) | 0.000 | 47(30.6) | 108(69.4) | 0.063 | 29(32.3) | 68(67.7) | 0.018 |

| Table 4. Use of Medicinal plants during COVID-19. |
|-----------------------------------------------|
| **Medicinal Plant** | **Common name** | **Use during pandemic** |
| Pimpinella anisum | Aniseed | 71(23.6) |
| Origanum majorana | Sweet marjoram | 23(7.7) |
| Carum carvi | Caraway | 26(8.6) |
| Trigonella foenum-graecum | Fenugreek | 56(17.8) |
| Curcuma longa | Turmeric | 91(31.6) |
| Glycyrrhiza glabra | Liquorice | 48(15.9) |
| Salvia rosmarinus | Rosemary | 41(13.6) |
| Zingiber officinalis | Ginger | 142(47.2) |
| Ocimum basilicum | Basil | 30(10.0) |

Thus, the observed use of vitamin and zinc supplements during the COVID-19 pandemic is justified by the available literature.

The present findings showed increased use of immune-boosting drinks, honey, and garlic. The drinks include lemon juice, orange juice, green tea, star anise, mint, marjoram, and hibiscus. These drinks are rich in minerals and vitamins that boost the immune system (Alkhatibi, 2020). In a study that conducted in Italy, about 60.9% of respondent believed that strengthening immune defenses through nutrition (includes supplements and immune-boosting foods) is important to lower COVID-19 infection (Savarese et al., 2020). In a survey that includes five metropolises and twelve countries, the use of ginger, onion, and lemon to fight COVID-19 was reported (Pieroni et al., 2020). Honey and bee products enhance the function of the immune system via enhancing immunoglobulin production, maturation of immune cells, and triggering of the different immune responses (Lima and Brito, 2020). Garlic, on the other hand, is a potent stimulant of the immune system (Ried, 2016). Garlic has also strong antiviral activity and is suggested to be useful in the prevention and management of COVID-19 infection (Rizzo et al., 2020; Rouf et al., 2020). The results showed that the use of some medicinal plants during the COVID-19 pandemic among Egyptians. The examined plants are traditionally used as medications in Egypt. The most common method of use is soaking the plant parts in hot water for some time and then drinking the liquid. The plant part can also be used as food additives. A notable use of Zingiber officinalis (47.2%) and Curcuma longa (31.6%) was observed. Zingiber officinalis is very rich in gingerols, shogaols, paradols, and volatile compounds (Dall’Acqua et al., 2019; Sultan et al., 2014), whereas Curcuma longa is very rich in curcumin. These compounds are effective mediators of the immune system (Catanzano and Corsini, 2018; Pereira et al., 2011; Sultan et al., 2014) and thus can modulate COVID-19.
infection (Gupta et al., 2020; Thota and Balan, 2020). *Pimpinella anisum* was reported to be used by about one-fourth of participants. It contains lignin-carbohydrate-protein complexes that possess antiviral and immune-stimulating effects (Lee et al., 2011). The other examined medicinal plants (*Origanum majorana, Carum carvi, Glycyrrhiza glabra, Ocimum basilicum*) were used but less frequently. Such plants have also been shown to possess immune enhancement effects (Garg et al., 2020; Mardani et al., 2016; Sun et al., 2019; Yousefi et al., 2021). Thus, the use of available and natural boosters of the immune system that help in the management of COVID19 should be encouraged. Enhancing the public knowledge and awareness regarding the benefits of such natural nutrients is an urgent demand.

The increase in the use of vitamin and zinc supplements, honey, garlic, and medicinal plants among Egyptians is associated with age and fear from COVID-19. As mentioned above, complications of COVID-19 infection are associated with age. Thus, the observed associations between age/fear and the use of agents that modulate COVID-19 symptoms are an urgent demand. Thus, a larger study that covers major areas in Egypt is required to confirm these findings.

Among the limitations of the current study is the relatively small sample size. In addition, an online sampling approach was utilized and this might prevent the participation of individuals with no/limited internet services. Thus, a larger study that covers major areas in Egypt is strongly recommended.

5. Conclusion

The study examined the use of supplements, medicinal plants, and immune-boosting drinks among the Egyptian population during the COVID-19 pandemic. The use of such nutrition was reported by approximately one-third of the study participants and was found to be associated with age and fear of the virus. The present findings may help understand certain health practices related to the COVID-19 pandemic that might be considered by health policymakers. Understanding factors associated with supplements/immune booster foods use may assist to design interventions that aim to disseminate accurate information and to motivate individuals towards healthy use of supplements, immune boosters, and medicinal plants for the sake of COVID-19 prevention during the pandemic.

Declarations

**Author contribution statement**

Omar F. Khabour, Salwa F. M. Hassanein: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

**Funding statement**

This work was supported by Jordan University of Science and Technology (245/2020).

**Data availability statement**

Data will be made available on request.

**Declaration of interests statement**

The authors declare no conflict of interest.

**Additional information**

No additional information is available for this paper.

**References**

Ahout, D.K., Lin, C.Y., Imasi, V., Saffari, M., Griffiths, M.D., Palpou, A.H., 2020. The fear of COVID-19 scale: development and initial validation. Int. J. Ment. Health Addiction 1–5.

Ali, N., 2020. Role of vitamin D in preventing of COVID-19 infection, progression and severity. J. Inf. Publ. Health 13, 667–673.

Alkhalifi, A., 2020. Antiviral functional foods and exercise lifestyle prevention of coronavirus. Nutrients 12.

Boretti, A., Banik, B.K., 2020. Intravenous vitamin C for reduction of cytokines storm in acute respiratory distress syndrome. PharmacolNutrition 12, 100169.

Brown, J.D., Voori, S.M., Mazini, T.M., 2020. Survey-reported Medication Changes Among Older Adults during the SARS-CoV-2 (COVID-19) Pandemic. Research in social & administrative pharmacy : RSAP.

Carr, A.C., 2020. A new clinical trial to test high-dose vitamin C in patients with COVID-19. Front. Immunol. 11, 1481.

Catanaro, M., Corsini, E., 2018. Immunomodulators Inspired by Nature: A Review on Curcumines and Echinaceas, p. 23.

Dall’Acqua, S., Grabner, I., Verardo, R., Klaric, E., Marchionni, L., Luidy-Imada, E., Sut, S., Agontink, C., Bulla, R., Perinutti, B., et al., 2019. Combined extracts of Echinacea angustifolia DC. and Zinger officinale Rosaff in softgel capsules: pharmacokinetics and immunomodulatory effects assessed by gene expression profiling. Phytomed.: Int. J. Phytother. Phytopharm. 65, 153090.

Esakandari, H., Nabi-Afjadi, M., Fakarki-Afjadi, J., Farahmandian, N., Miresmaeili, S.M., Bahreiini, J., 2020. A Comprehensive Review of COVID-19 Characteristics, p. 19, 22.

Feyaerts, A.F., Luyten, W., 2020. Vitamin C as prophylaxis and adjunctive medical treatment for COVID-19. Front. Immunol. 11, 1481.

Galmes, S., Sierra, F., 2020. Current State of Evidence: Influence of Nutritional and Nutrigenetic Factors on Immunity in the COVID-19 Pandemic Framework, 12.

Garcia, L.F., 2020. Immune response, inflammation, and the clinical spectrum of COVID-19. Front. Immunol. 11, 1481.

Garg, S., Anand, A., Lamba, Y., Roy, A., 2020. Molecular docking analysis of selected phytochemicals against SARS-CoV-2 M (pro) receptor. Vegetos 1–16.

Gupta, S., Singh, A.K., Kushwaha, P.P., Pratapjati, K.S., Shuab, M., Senapati, S., Kumar, S., 2020. Identification of Potential Natural Inhibitors of SARS-CoV2 Main Protease by Molecular Docking and Simulation studies, Pages 1–12.

Hamulka, J., Jerusza-Bielak, M., Gornicka, M., Drywick, M.E., Zielinska-Pokus, M.A., 2020. Dietary supplements during COVID-19 outbreak. Results of Google Trends analysis supported by ProFileCOVID-19 online studies. Nutrients 13.

Harapan, H., Ichób, N., Uyfik, A., Winardi, W., Kean, S., Te, H., Megawati, D., Hayati, Z., Wagner, A.L., Mudatir, M., 2020. Coronavirus disease 2019 (COVID-19): a literature review. J. Inf. Publ. Health 13, 667–673.

Huang, L., Lim, M.A., Prona, R., 2020. Diabetes mellitus is associated with increased mortality and severity of disease in COVID-19 pneumonia - a systematic review, meta-analysis, and meta-regression. Diabetes Metab. Syndr. 14, 395–403.

Idmir, M., Brito, A., Dinggo, G., Fernandez Del Campo, S.S., Samouda, H., La Frano, M.R., 2020. Strengthening the Immune System and Reducing Inflammation and Oxidative Stress through Diet and Nutrition: Considerations during the COVID-19 Crisis, p. 12.

Jothimani, D., Kailasam, E., Danielraj, S., Nallathambi, B., Ramachandran, H., Sekar, P., Manoharan, S., Ramani, V., Narasimhan, G., Kallanmorothy, I., et al., 2020. COVID-19: poor outcomes in patients with Zinc deficiency. Int. J. Dev. LIFD: Off. Publ. Int. Soc. Infect. Dis.

Karbowińska, M.S., Dobieslka, M., Paul, E., Kowalczyk, R.P., Kowalczyk, E., 2020. Health, Medication and Dietary Supplement-Related Behaviors and Beliefs Relatively Unchanged during the COVID-19 Pandemic Lockdown. Research in social & administrative pharmacy : RSAP.

Lee, J.B., Yamauchi, C., Hayashi, K., Hayashi, T., 2011. Antiviral and immunostimulating effects of lignin-carbohydrate-protein complexes from *Pimpinella anisum*. Biosci. Biotechnol. Biochem. 75, 459–465.

Li, R., Wu, K., Li, Y., Liang, X., Tse, W.K.F., Yang, L., Lai, K.P., 2020. Revealing the targets and mechanisms of vitamin A in the treatment of COVID-19. Aging 12, 15784–15796.

Lima, W.G., Brito, J.C.M., 2020. Bee Products as a Source of Promising Therapeutic and Chemoprophylaxis Strategies against COVID-19 (SARS-CoV-2).

Lovely, G.A., Sen, R., 2016. Evolving adaptive immunity. Gene Dev. 30, 873–875.

Ludvigsson, J.F., 2020. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. Acta Paediatr. 109, 1088–1095 (Oslo, Norway : 1992).

Mardani, M., Afra, S.M., Tanideh, N., Tadbiz, A.A., Modaresi, F., Koochi-Hoseinabadi, O., Irj, A., Sepehrmanesh, M., 2016. Hydroalcoholic extract of *Carum carvi* L. in oral mucositis: a clinical trial in male golden hamsters. Oral Dis. 22, 39–45.

Muniyappa, R., Gubbi, S., 2020. Taming the Coronavirus disease 2019 (COVID-19) Pandemic? The Importance of Homemade Plant-based Foods and Beverages as Community Responses to COVID-19. Research in social & administrative pharmacy : RSAP.

Perreira, M.M., Haniadka, R., Chacko, P.P., Palatty, P.L., Baliga, M.S., 2011. Zinger officinale Rosaceae (ginger) as an adjuvant in cancer treatment: a review. J. BUON: Off. J. Ital. Union Oncol. 16, 414–424.

Pieris, A., VandeBroek, I., Prakofjewa, J., Bussmann, R.W., Pania-Zamba, N.Y., Mannyi, A., Torri, L., Zocchi, D.M., Dam, A.T.K., Khan, S.M., et al., 2020. Taming the pandemic? The importance of homemade plant-based foods and beverages as community responses to COVID-19. J. Ethnobot. Ethnomed. 16, 75.
Prasad, A.S., 2008. Zinc in human health: effect of zinc on immune cells. Mol. Med. (Cambridge, Mass) 14, 353–357.

Rhodes, J.M., Subramanian, S., Laird, E., Griffin, G., Kenny, R.A., 2020. Perspective: vitamin D deficiency and COVID-19 severity - plausibly linked by latitude, ethnicity, impacts on cytokines, ACE2 and thrombosis. J. Intern. Med.

Ried, K., 2016. Garlic lowers blood pressure in hypertensive individuals, regulates serum cholesterol, and stimulates immunity: an updated meta-analysis and review. J. Nutr. 146, 389s–396s.

Rizzo, A., Sciorsci, R.L., Magrone, T., Jirillo, E., 2020. Exploitation of some natural products for prevention and/or nutritional treatment of SARS-CoV2 infection. Endoer. Metab. Immune Disord. Drug Targets.

Rouf, R., Uddin, S.J., Sarker, D.K., Islam, M.T., Ali, E.S., Shilpi, J.A., Nahar, L., Tiralongo, E.,arker, S.D., 2020. Antiviral potential of garlic (Allium sativum) and its organosulfur compounds: a systematic update of pre-clinical and clinical data. Trends Food Sci. Techn. 104, 219–234.

Savarese, M., Castellini, G., Morelli, L., Graffigna, G., 2020. COVID-19 Disease and Nutritional Choices: How Will the Pandemic Reconfigure Our Food Psychology and Habits? A Case Study of the Italian Population. Nutrition, Metabolism, and Cardiovascular Diseases. NMCD.

She, J., Liu, L., 2020. COVID-19 Epidemic: Disease Characteristics in Children, pp. 747–754, 92.

Sultan, M.T., Butt, M.S., Qayyum, M.M., Suleria, H.A., 2014. Immunity: plants as effective mediators. Crit. Rev. Food Sci. Nutr. 54, 1298–1308.

Sun, Z.G., Zhao, T.T., Lu, N., Yang, Y.A., Zhu, H.L., 2019. Research progress of glycyrrhizic acid on antiviral activity. Mini Rev. Med. Chem. 19, 826–832.

Takhar, A., 2020. Pernicious anaemia: switch to oral B12 supplementation to reduce risk of covid-19 transmission. BMJ (Clinical research ed) 369, m2383.

Thaiss, C.A., Zmora, N., Levy, M., Elray, E., 2015. The microbiome and innate immunity. Nature 535, 65–74.

Thota, S.M., Balan, V., 2020. Natural Products as home-based Prophylactic and Symptom Management Agents in the Setting of COVID-19. Sun Yusuf, W.N., Wan Mohammad, W.M.Z., Gan, S.H., Mustafa, M., Abd Aziz, C.B., Sulaiman, S.A., 2019. Tualang honey ameliorates viral load, CD4 counts and improves quality of life in asymptomatic human immunodeficiency virus infected patients. J. Tradit. Compl. Med. 9, 249–256.

Thota, S.M., Balan, V., 2020. Natural Products as home-based Prophylactic and Symptom Management Agents in the Setting of COVID-19. J. Intern. Med. 146, 389s–396s.