Effect of natural products use prior to infection with COVID-19 on disease severity and hospitalization: A self-reported cross-sectional survey study [version 2; peer review: 1 approved, 1 approved with reservations]

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Abstract

Background: Managing coronavirus disease 2019 (COVID-19) using available resources is essential to reduce the health burden of disease. The severity of COVID-19 is affected by nutritional status. In this study the effect of natural product use prior to infection with COVID-19 on disease severity and hospitalization was explored.

Methods: This was a cross-sectional study. Between March and July 2021, a self-administered survey was conducted in Jordan. Individuals who recovered from COVID-19 and were ≥18 years old were the study population. Study measures included the use of natural products, COVID-19 severity, and hospitalization status. A multivariate regression model was used for statistical analysis.

Results: The mean age (mean ± SD) of the study sample (n=2,148) was 40.25 ± 15.58 years old. Multivariate logistic regression showed that the regular intake of carnation (OR [0.56], CI [0.37–0.85]), onion (OR [0.69], CI [0.52–0.92]), lemon (OR [0.68], CI [0.51–0.90]), and citrus fruits (OR [0.66], CI [0.50–0.89]) before infection were associated with a substantial reduction in COVID-19 severity (P<0.01). Also, the consumption of carnation (OR [0.55], CI [0.34–0.88]), lemon (OR [0.57], CI [0.42–0.78]), and citrus fruits (OR [0.61], CI [0.44–0.84]) were associated with a significant decrease in the frequency of COVID-19-induced hospitalization (P<0.01).

Conclusions: Regular consumption of carnation, lemon, and citrus fruits before infection was associated with better outcomes for COVID-19. Studies on other populations are required to confirm these findings.

Keywords
COVID-19, natural products, carnation, onion, lemon, citrus, hospitalization, severity
Introduction

Coronavirus disease 2019 (COVID-19) is a global pandemic due to the SARS-CoV-2 that causes severe acute respiratory syndrome.\(^1,2\) Since the World Health Organization (WHO) declared the pandemic in March, 2020, the mortality toll from COVID-19 worldwide has passed six million by April 2022.\(^3\) SARS-CoV-2 can cause a wide variety of symptoms, from asymptomatic infection to severe acute respiratory syndrome and death.\(^4,5\)

Maintaining a healthy diet has been suggested as a way to boost immune functions and protect against severe infections.\(^6\) Certain foods and natural products contain bioactive constituents that have immunomodulating, anti-inflammatory, antioxidant, antibacterial, and antiviral properties. Hence, they can be used for pre- and post-exposure prophylaxis to enhance the activity and quantity of cytokines and different types of white blood cells.\(^7\) Therefore, natural products may enhance viral infection outcomes by reducing inflammation and respiratory symptoms.\(^8\)

Most people in the Middle East region still consume traditional medicinal herbs, immune-boosting foods, and drinks as part of their diet.\(^9-11\) During the pandemic, increased demand on medicinal natural products certain foods, drinks, and medicinal herbs such as ginger, garlic, turmeric, and citrus fruits, has been observed.\(^12-14\)

Several studies have examined the effect of consumption of certain foods, drinks, and medicinal herbs on COVID-19 progression.\(^5,16\) However, the method of preparing and consuming these natural products may vary for different populations, which may affect the desired benefits of these products. In addition, each geographical area or country may have unique medicinal herbs and immunomodulatory foods. In Jordan, the effect of regular consumption of certain immune-boosting foods and medicinal herbs prior to infection with COVID-19 on the clinical course has not yet been investigated. Due to the seriousness of COVID-19, we hypothesized that an increase in the use of some immune-boosting foods and medicinal herbs would be associated with a less severe form of COVID-19. Therefore, the current study examined the association between the use of many natural products prepared from natural sources at home and foods that boost the immune system (green tea, black caraway, Indian costus, cumin, turmeric, anis, chamomile, propolis, honey, carnation, star anis, onion, garlic, lemon, and citrus fruits) before infection with the risk of COVID-19 severity and hospitalization in Jordan. The selected natural products are the most widely used in Jordan.

Methods

Study design and subjects

This cross-sectional survey was carried out in Jordan (between March and July 2021) as part of the Jordanian COVID-19 survey project (JCSIP).\(^17\) The Institutional Review Board of Jordan University of Science and Technology granted ethical approval for the project (Ref.: 3/139/2021, dated 30/03/2021). Adults (≥18 years old) who recovered from COVID-19 were included in the current investigation. Participants were recruited from public places such as bus stations, parks, religious places, universities, and restaurants. The cover page of the questionnaire outlined the criteria for participation in the study, which included infection with COVID-19 and recovery from illness. Research assistants emphasized to participants that infection should have been confirmed by polymerase chain reaction (PCR). Exclusion criteria included current COVID-19 infection and vaccination prior to contracting the virus. Persons previously vaccinated were excluded since vaccination has a considerable influence on disease severity and may mask the potential benefits of the consumption of medicinal herbs and immune-boosting foods on the dependent variables of the study. This cross-sectional study was designed as recommended by the STROBE checklist.\(^18\)
Study instrument
The current study used a self-administered questionnaire in Arabic, which can be found translated into English as
Underlying data. Participants were asked about their demographics (age, gender, body mass index (BMI), and
education), comorbidities, and consumption of medicinal herbs and immune-boosting foods before infection with
COVID-19. Furthermore, infection symptoms and admission to hospital data were gathered. A panel of area specialists
validated the questionnaire, which was then piloted on a limited number of participants. The opinions of experts and
participants were gathered and utilized to assess and enhance the clarity of the questionnaire. Results of the first draft of
the questionnaire were excluded from the final analysis. The principal investigators’ involvement in data collection was
minimized to reduce sources of bias. Participants were chosen to represent various Jordanian geographical regions, and
information was gathered from them through an online questionnaire supplied to participants by trained research
assistants. We used specific techniques to reduce response bias as much as possible. First, the researcher did not interpret
the questionnaire because it was self-administered. Second, we double-checked the items’ clarity by translating them into
Arabic. Finally, all duplicate entries were eliminated.

Sample size calculation
The sample size for our study was calculated using the online Raosoft sample size calculator (Raosoft Inc., Seattle, WA,
USA). According to the world meter elaboration of the most recent United Nations data, Jordan’s population is around
10 million people. The confidence level was set at 95%, the margin of error was set at 3%, and the response distribution
was set at 50%. With 770,712 confirmed cases, including children, reported by the end of July 2021, the recommended
sample size was 1067. Of note, the number of cases under the age of 18 at the time of sample collection, which occurred
before the emergence of the Omicron variant, was expected to be small compared to adult cases (no data available).
Therefore, if cases under 18 years of age were subtracted from the total, it would lead to a negligible change in the sample
size. However, the size of the sample recruited (n = 2,148) was larger than what was required to represent the COVID-19
cases in Jordan, even if child cases were taken into consideration.

Recruitment of subjects
A convenient sampling procedure was used in the study. “Google Forms” was used to create and administer the survey.
To ensure anonymity, the study did not collect identifying information, such as participants’ names and places of work.
In addition, the data were saved in encrypted digital format that required a password to access. The first section of the
questionnaire sought informed consent and confirmed recovery from COVID-19. All participants provided informed
consent. Anyone could opt out and withdraw from the survey by not submitting their answers, so participation was
entirely voluntary. To ensure that the Jordanian population is adequately represented, trained researchers recruited
participants from various Jordanian governorates. The questionnaire was completed by a total of 2,148 participants.

Classification of COVID-19 severity
Based on symptoms, the severity of COVID-19 infection was classified into two categories; severe and non-severe
(asymptomatic, mild symptoms, and moderate), as previously reported. Fever, sore throat, body pains, and nausea,
with no signs or symptoms of pneumonia, were considered mild cases. Pneumonia (persistent fever and cough) but no
hypoxemia (arterial oxygen saturation measured by pulse oximetry (SpO2) ≤ 92%) were considered moderate cases.
Confirmed severe pneumonia and hypoxemia were considered severe cases. It is worth noting that during peak
COVID-19 waves, several patients were not admitted to hospitals because of the increased burden on hospitals. As
a result, such cases received medical care at home through private doctor visits, and some used medical oxygen supply
systems in their homes.

Statistical analysis
In this study, the independent variables were the use of natural products (medicinal herbs, immune-boosting foods),
whereas the dependent variables were COVID-19 severity and hospitalization. All data with missing values were
excluded from the analysis. For different variables, percentages, frequencies, means, and standard deviations (SD), were
used as appropriate. The Chi-squared test was utilized to determine any differences in severity/hospitalization between
users of natural products. Multivariate logistic regression was applied to examine the impact of natural food use on the
severity/hospitalization while controlling for different confounders. The adjusted odds ratios (OR) and 95% confidence
interval (CI) were presented. P<0.05 indicates statistical significance. The data were analyzed using IBM SPSS Statistics
v23 (RRID:SCR_016479).

Results
Demographic characteristics of the participants
The questionnaire was completed by 2,148 participants. The demographics of the sample are summarized in Table 1.
Women comprised 58.2% of participants. The participants’ mean age was 40.25±15.58 years. The majority of
participants had non-severe COVID-19 infection and were not admitted to hospitals (87.9% and 89.8%, respectively). Among the participants, 16.9% were smokers, and 23.1% had at least one comorbidity (Table 1).

Association of natural products use with COVID-19 severity and hospitalization
COVID-19 severity/hospitalizations were investigated in relation to the use of medicinal herbs and immune-boosting foods (Table 2). Lemon and citrus fruits were associated with lower incidence of severe COVID-19 and hospitalization (P<0.01). Moreover, intake of ginger and green tea was associated with reduced disease severity (P=0.018 and P=0.036, respectively). However, no significant effects on severe COVID-19 and hospitalization outcomes were observed due to consumption of anise, chamomile, propolis, honey, onions, garlic, carnation, star anise, black caraway, Indian costus, and turmeric, prior to infection.

Regression model
The multivariate logistic regression model was performed to account for potential confounders and comorbidities. The data are shown in Table 3 for two outcomes: COVID-19 severity and hospitalization status with the use of each natural product. After controlling for covariates (age, gender, BMI, cigarette smoking status, and the number of comorbidities), the findings (Table 3) showed that consumption of carnation (P<0.01), onion (P<0.01), lemon (P<0.01), and citrus fruits (P<0.01) were predictors of lower disease severity. In addition, the consumption of carnation (P<0.01), lemon (P<0.001), and citrus fruits (P<0.01), were predictors of reduced hospitalizations due to COVID-19 infection (Table 3).

Discussion
COVID-19 can show a spectrum of clinical symptoms from mild to severe respiratory distress and death. It is suggested that the nutritional status of people may influence COVID-19 clinical severity. In the current study, the effects of using natural products prior to infection with COVID-19 on disease severity and hospitalization were examined. Previous studies have examined the associations between the severity of infection with the intake of immune-boosting foods and medicinal herbs. According to the literature, there is no evidence that natural products and medicinal herbs impart protection from or cure COVID-19. However, consumption of natural products before becoming infected with COVID-19 may boost the immune system and lead to favored disease outcomes. The current study found that regular consumption of carnation, lemon, and citrus fruits, before infection was associated with better outcomes for COVID-19.

Table 1. Demographics of the sample.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported age (years)</td>
<td></td>
</tr>
<tr>
<td>18-40</td>
<td>1203 (56.0)</td>
</tr>
<tr>
<td>41-60</td>
<td>684 (31.8)</td>
</tr>
<tr>
<td>More than 60</td>
<td>261 (12.2)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>903 (42.0)</td>
</tr>
<tr>
<td>Female</td>
<td>1245 (58.0)</td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
</tr>
<tr>
<td>≤24.9</td>
<td>723 (33.7)</td>
</tr>
<tr>
<td>25-29.9</td>
<td>786 (36.6)</td>
</tr>
<tr>
<td>≥30</td>
<td>639 (29.7)</td>
</tr>
<tr>
<td>Tobacco use</td>
<td>362 (16.85)</td>
</tr>
<tr>
<td>Chronic diseases</td>
<td>496 (23.09)</td>
</tr>
<tr>
<td>COVID-19* infection status</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>260 (12.10)</td>
</tr>
<tr>
<td>Non-severe disease</td>
<td>1,888 (87.89)</td>
</tr>
<tr>
<td>Admitted to hospital</td>
<td>219 (10.19)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Did you consume</th>
<th>Non-severe</th>
<th>Severe</th>
<th>P-value</th>
<th>hospitalized</th>
<th>Yes</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>anise before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,029</td>
<td>87.4%</td>
<td>148</td>
<td>12.6%</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>827</td>
<td>88.5%</td>
<td>107</td>
<td>11.5%</td>
<td>0.44</td>
</tr>
<tr>
<td>chamomile before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,229</td>
<td>87.7%</td>
<td>173</td>
<td>12.3%</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>628</td>
<td>88.8%</td>
<td>79</td>
<td>11.2%</td>
<td>0.79</td>
</tr>
<tr>
<td>propolis before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,714</td>
<td>87.9%</td>
<td>235</td>
<td>12.1%</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>101</td>
<td>87.1%</td>
<td>15</td>
<td>12.9%</td>
<td>0.79</td>
</tr>
<tr>
<td>honey before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,023</td>
<td>88.3%</td>
<td>135</td>
<td>11.7%</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>840</td>
<td>87.8%</td>
<td>117</td>
<td>12.2%</td>
<td>0.69</td>
</tr>
<tr>
<td>onions before COVID infection to boost your immune system</td>
<td>No</td>
<td>993</td>
<td>87.1%</td>
<td>147</td>
<td>12.9%</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>863</td>
<td>88.9%</td>
<td>108</td>
<td>11.1%</td>
<td>0.21</td>
</tr>
<tr>
<td>garlic before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,075</td>
<td>88.2%</td>
<td>144</td>
<td>11.8%</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>784</td>
<td>87.8%</td>
<td>109</td>
<td>12.2%</td>
<td>0.78</td>
</tr>
<tr>
<td>carnation before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,515</td>
<td>87.5%</td>
<td>217</td>
<td>12.5%</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>320</td>
<td>90.4%</td>
<td>34</td>
<td>9.6%</td>
<td>0.12</td>
</tr>
<tr>
<td>star anise before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,580</td>
<td>87.6%</td>
<td>224</td>
<td>12.4%</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>251</td>
<td>90.3%</td>
<td>27</td>
<td>9.7%</td>
<td>0.20</td>
</tr>
<tr>
<td>ginger before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,157</td>
<td>86.9%</td>
<td>175</td>
<td>13.1%</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>708</td>
<td>90.3%</td>
<td>76</td>
<td>9.7%</td>
<td>0.02*</td>
</tr>
<tr>
<td>green tea before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,450</td>
<td>87.3%</td>
<td>211</td>
<td>12.7%</td>
<td>0.04*</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>393</td>
<td>91.0%</td>
<td>39</td>
<td>9.0%</td>
<td>0.04*</td>
</tr>
<tr>
<td>lemons before COVID infection to boost your immune system</td>
<td>No</td>
<td>674</td>
<td>86.1%</td>
<td>109</td>
<td>13.9%</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1,194</td>
<td>89.6%</td>
<td>139</td>
<td>10.4%</td>
<td>0.02*</td>
</tr>
<tr>
<td>citrus fruits before COVID infection to boost your immune system</td>
<td>No</td>
<td>574</td>
<td>84.8%</td>
<td>103</td>
<td>15.2%</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1,299</td>
<td>89.7%</td>
<td>149</td>
<td>10.3%</td>
<td>0.001*</td>
</tr>
<tr>
<td>Did you consume black caraway before COVID infection to boost your immune system</td>
<td>COVID-19 classification</td>
<td>Hospitalized</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-severe</td>
<td>Severe</td>
<td>P-value</td>
<td>No</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>No</td>
<td>1,503</td>
<td>87.8%</td>
<td>208</td>
<td>12.2%</td>
<td>0.44</td>
<td>1,537</td>
</tr>
<tr>
<td>Yes</td>
<td>333</td>
<td>89.3%</td>
<td>40</td>
<td>10.7%</td>
<td>338</td>
<td>90.6%</td>
</tr>
<tr>
<td>Did you consume Indian costus before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,736</td>
<td>87.9%</td>
<td>238</td>
<td>12.1%</td>
<td>0.56</td>
</tr>
<tr>
<td>Yes</td>
<td>97</td>
<td>89.8%</td>
<td>11</td>
<td>10.2%</td>
<td>99</td>
<td>91.7%</td>
</tr>
<tr>
<td>Did you consume cumin before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,502</td>
<td>88.1%</td>
<td>202</td>
<td>11.9%</td>
<td>0.70</td>
</tr>
<tr>
<td>Yes</td>
<td>341</td>
<td>87.4%</td>
<td>49</td>
<td>12.6%</td>
<td>351</td>
<td>90.0%</td>
</tr>
<tr>
<td>Did you consume turmeric before COVID infection to boost your immune system</td>
<td>No</td>
<td>1,554</td>
<td>88.0%</td>
<td>211</td>
<td>12.0%</td>
<td>0.91</td>
</tr>
<tr>
<td>Yes</td>
<td>289</td>
<td>87.8%</td>
<td>40</td>
<td>12.2%</td>
<td>300</td>
<td>91.2%</td>
</tr>
</tbody>
</table>


*P ≤ 0.05.
Table 3. Logistic regression analyses for medicinal herbals, natural products, and immune-boosting foods used with COVID-19 severity and hospitalization as the output.

<table>
<thead>
<tr>
<th>Substance consumed before COVID-19</th>
<th>Total number of users</th>
<th>Severity</th>
<th>Odds ratio (OR)</th>
<th>95% CI of OR</th>
<th>P-value</th>
<th>Hospitalization</th>
<th>Odds ratio (OR)</th>
<th>95% CI of OR</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Tea</td>
<td>432</td>
<td>0.13</td>
<td>0.75</td>
<td>0.51–1.10</td>
<td>0.26</td>
<td>0.78</td>
<td>0.52–1.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black caraway</td>
<td>373</td>
<td>0.07</td>
<td>0.70</td>
<td>0.48–1.04</td>
<td>0.11</td>
<td>0.71</td>
<td>0.47–1.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian costus</td>
<td>108</td>
<td>0.09</td>
<td>0.55</td>
<td>0.27–1.09</td>
<td>0.08</td>
<td>0.50</td>
<td>0.24–1.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumin</td>
<td>390</td>
<td>0.90</td>
<td>0.98</td>
<td>0.68–1.40</td>
<td>0.56</td>
<td>0.89</td>
<td>0.60–1.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turmeric</td>
<td>329</td>
<td>0.47</td>
<td>0.86</td>
<td>0.58–1.28</td>
<td>0.08</td>
<td>0.67</td>
<td>0.42–1.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anis</td>
<td>934</td>
<td>0.32</td>
<td>0.86</td>
<td>0.65–1.15</td>
<td>0.29</td>
<td>0.84</td>
<td>0.62–1.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chamomile</td>
<td>707</td>
<td>0.11</td>
<td>0.78</td>
<td>0.57–1.06</td>
<td>0.54</td>
<td>0.90</td>
<td>0.65–1.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propolis</td>
<td>116</td>
<td>0.54</td>
<td>0.83</td>
<td>0.45–1.51</td>
<td>0.99</td>
<td>1.00</td>
<td>0.54–1.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honey</td>
<td>957</td>
<td>0.33</td>
<td>0.87</td>
<td>0.65–1.16</td>
<td>0.78</td>
<td>0.96</td>
<td>0.70–1.31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carnation</td>
<td>354</td>
<td>0.01 *</td>
<td>0.56</td>
<td>0.37–0.85</td>
<td>0.01 *</td>
<td>0.55</td>
<td>0.35–0.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Star Anis</td>
<td>278</td>
<td>0.06</td>
<td>0.65</td>
<td>0.41–1.03</td>
<td>0.15</td>
<td>0.70</td>
<td>0.43–1.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onion</td>
<td>971</td>
<td>0.01 *</td>
<td>0.69</td>
<td>0.52–0.92</td>
<td>0.07</td>
<td>0.75</td>
<td>0.55–1.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garlic</td>
<td>893</td>
<td>0.25</td>
<td>0.84</td>
<td>0.63–1.13</td>
<td>0.31</td>
<td>0.85</td>
<td>0.62–1.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lemon</td>
<td>1333</td>
<td>0.01 *</td>
<td>0.68</td>
<td>0.51–0.90</td>
<td>&lt;0.001 *</td>
<td>0.57</td>
<td>0.42–0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrus fruits</td>
<td>1448</td>
<td>0.01 *</td>
<td>0.66</td>
<td>0.50–0.89</td>
<td>0.002 *</td>
<td>0.61</td>
<td>0.44–0.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each independent variable was adjusted for confounders, and comorbidities. COVID-19, coronavirus disease 2019.

*P ≤ 0.05.
Of note, lemon was kept as a separate category from citrus because some studies have shown differences in their nutritional values.53,26

This study found that carnation use by the participants reduced COVID-19 hospitalizations and disease severity. Due to its therapeutic uses, carnation is nominated as a candidate for the management of COVID-19.27–30 During the COVID-19 pandemic, the consumption of carnation as an additive to food or drink to relieve throat pain has increased.31 A randomized clinical trial of a blend that contains carnation buds demonstrated a boost in energy levels among post-COVID-19 female patients.32 In addition, carnation has antibacterial, antiviral, and antifungal effects, and is used to kill germs in dental creams, toothpaste, mouthwash formulations, and throat sprays.23,33 The mechanism by which carnation may reduce the severe form of COVID-19 involves interference of SARS-CoV-2 S1-protein binding to the angiotensin-converting enzyme 2 (ACE2) receptor.34 Moreover, carnation has been shown to increase the availability of oxygen by improving blood supply to both the heart and the brain.35 Carnation has also been reported to be beneficial for the management of chronic coughs, shortness of breath, and maintaining a normal heart rate.36

The current study also showed a significant decrease in the frequency of the severe form of COVID-19 and hospitalization due to the consumption of lemon and citrus. Citrus fruits are known to contain a variety of bioactive constituents, including vitamin C, anthocyanin, and flavonones,37 which offer a variety of health benefits, such as the normalization of oxidants and inflammation.38,39 Furthermore, citrus fruits, such as oranges and grapefruits, are grown in Jordan, making them a readily available natural source of vitamin C.40 Citrus fruits are commonly used by Jordanians to improve the body’s immunity against COVID-19 infection.11 Similar to carnation, active ingredients in citrus fruits can interfere with binding of SARS-CoV-2 to the ACE2 receptor.41,42 Moreover, naringin of citrus fruits has been shown to suppress the expression of proinflammatory cytokines during the inflammatory response.41,43 Furthermore, hesperidin, a biologically active molecule in orange fruit, was shown to inactivate the SARS-CoV-2 RNA polymerase complex.44,45 The antioxidant components of citrus fruits can also protect against oxidative stress associated with COVID-19 infection.46

Onion has been shown to significantly reduce the frequency of severe illness among participants who consumed it regularly. Onion has antiviral, antifibrotic, antioxidant, and anti-inflammatory bioactive compounds, such as quercetin, apigenin, and selenium.38,47 In several studies, onion and its bioactive components reduced inflammation in the lungs and protected against various respiratory illnesses.38–40 It is suggested that phytochemicals derived from onions can interfere with the function of the main protease of SARS-CoV-2.41–55 In addition, anti-inflammatory diets that incorporate onions were recommended to reduce the severity of COVID-19.12,54,55

Although honey and ginger were among the most consumed natural products for the prevention or mitigation of COVID-19 symptoms in Jordan,11 results showed no impact of ginger and honey on the rate of hospitalization and disease severity. Ginger is suggested as a natural product for the management of COVID-19.27 In contrast to the current findings, Aldwihi et al., showed that patients who consumed ginger were less likely to be hospitalized.57 Moreover, a decrease in COVID-19 severity was observed among patients who consumed ginger as treatment.58 According to clinical trials, honey (propolis), a resinous substance made by bees, may help reduce viral clearance time and improve clinical COVID-19 outcomes by interfering with viral replication and entry.59–61 However, the effects of honey were observed in a limited number of studies involving small sample sizes.62 Thus, more investigations are required to confirm the role of bee products in the management of COVID-19.

According to the logistic regression analysis, no associations were observed due to consumption of green tea, black caraway, Indian costus, cumin, turmeric, anis, chamomile, star anis, and garlic with COVID-19 hospitalizations and severity. While several studies have revealed the anti-inflammatory and antiviral effects of many of these natural products,63–67 their contribution toward reducing COVID-19 severity is highly controversial, and requires preclinical and clinical trial evaluations, and validation using models of the disease.8,66 Among the study’s limitations is that the total number and quantity of natural products used by the subjects were unknown. In addition, the method of consuming carnation, the most active natural product to protect against severe COVID-19, was not investigated.

Furthermore, data on the duration of COVID-19 and hospitalization were not collected. Finally, since the study collected retrospective data, the data may be subject to recall bias. As a result, more studies are required to verify the study findings.

Conclusions

The study findings showed that the regular consumption of lemon, citrus fruits, and carnation lowers the rates of COVID-19 severity and hospitalization. Studies in other populations are required to confirm these findings.
Data availability

Underlying data

Figshare: Natural Products Raw Data. https://doi.org/10.6084/m9.figshare.19758820

This project contains the following underlying data:

- Natural products Raw Data.xlsx (survey responses from all participants)
- Questionnaire in English.docx

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

References


Open Peer Review

Current Peer Review Status: ✔️ ?

**Version 2**

Reviewer Report 13 July 2022

https://doi.org/10.5256/f1000research.135778.r143817

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✔️ Fatin Y. Atrooz
Department of Pharmacological and Pharmaceutical Sciences, College of Pharmacy, University of Houston, Houston, TX, USA

Approved.

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Behavioral neuroscience, cytogenetics, public health research.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

**Version 1**

Reviewer Report 28 June 2022

https://doi.org/10.5256/f1000research.133852.r140506

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❓ Caterina Vicidomini
Istituto di Biostrutture e Bioimmagini IBB-CNR, Naples, Italy

In this paper, the authors retrospectively explored the effect of a series of natural products use prior to infection with COVID-19 on disease severity and hospitalization. The authors hypothesized that an increase in the use of some immune-boosting foods and medicinal herbs would be
associated with a less severe form of COVID-19 infection. Study measures included the use of selected natural products, COVID-19 severity, and hospitalization status. A multivariate regression model was used for statistical analysis.

In my opinion, this paper has some limitations including those the authors have described in the text. The total number and quantity of natural products used by the subjects were unknown, and also, I didn't find any information on whether the participants consumed these natural products as commercial supplements, or if they prepared them from natural sources at home, for example.

In any case, the work seems interesting and provides ideas for research insights. In my opinion it is therefore worthy of indexing.

I have just a few suggestions:
- Provide some information on the recruitment method adopted.
- Specify, at least for the most active products such as carnation, how it is usually consumed.
- Reading the questionnaire, I saw that the authors collected data on potential confounders and comorbidities, but they didn't specify anything on this aspect. Please, add what they considered confounders. If possible, it would be interesting to evaluate whether, for example, the cigarette smoking modified the beneficial effect of natural substances intake.
- I know that there are other natural substances traditionally used to boost the immune system, but they were not mentioned or considered in the study. Please add a comment in the text and cite at least the following reference.1

References

Is the work clearly and accurately presented and does it cite the current literature? 
Partly

Is the study design appropriate and is the work technically sound? 
Yes

Are sufficient details of methods and analysis provided to allow replication by others? 
Yes

If applicable, is the statistical analysis and its interpretation appropriate? 
Partly

Are all the source data underlying the results available to ensure full reproducibility? 
Yes

Are the conclusions drawn adequately supported by the results?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Environmental chemistry & human health. Computational studies. Synthesis of small molecules

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 02 Jul 2022

**Refat Nimer**, Jordan University of Science and Technology, Irbid, Jordan

We would like to thank the reviewers for careful and thorough reading of this manuscript and for the thoughtful comments and constructive suggestions, which helped to improve the quality of this manuscript.

Please find attached a point-by-point response to reviewers' concerns. We hope that you find our responses satisfactory and that the manuscript is now acceptable for publication.

**Reviewer #2 (Comments to the Author):**

In my opinion, this paper has some limitations including those the authors have described in the text. The total number and quantity of natural products used by the subjects were unknown...

**Authors' response:** We agree with the reviewer that the rate of consumption of these natural products was unknown. However, this point was mentioned in the limitations (highlighted in red).

And also, I didn't find any information on whether the participants consumed these natural products as commercial supplements, or if they prepared them from natural sources at home, for example.

**Authors' response:** This study focuses on natural products, not commercial supplements. However, the point raised by the reviewer is now incorporated in the revised manuscript.

Provide some information on the recruitment method adopted.

**Authors' response:** More information was added at “Study design and subjects” section.

Specify, at least for the most active products such as carnation, how it is usually consumed.

**Authors' response:** Your suggestion is now incorporated in the updated version of the manuscript.

Reading the questionnaire, I saw that the authors collected data on potential confounders and comorbidities, but they didn't specify anything on this aspect. Please, add what they considered confounders. If possible, it would be interesting to evaluate whether, for example, the cigarette smoking modified the beneficial effect of natural substances intake.

**Authors' response:** COVID-19 was reported to be more severe in people having high BMI or comorbidities. However, the aim of this study was to explore the effect of using natural
products on the severity of the disease, regardless of the confounding factors. Therefore, multivariate regression analysis was applied to control for possible confounding factors such as age, gender, cigarette smoking, and the number of comorbidities (Table 3). The analysis without adjusted confounding factors is shown in Table 2. The point raised by the reviewer is now discussed in the revised manuscript.

I know that there are other natural substances traditionally used to boost the immune system, but they were not mentioned or considered in the study. Please add a comment in the text and cite at least the following reference. PMID: 33511704

**Authors’ response:** We agree with the reviewer’s comment. However, this study covered the broadest range of natural products used by the Jordanian population. The point raised by the reviewer is now incorporated in the revised manuscript (the last sentence in the introduction) and the proposed reference was added (ref no. 14).

**Competing Interests:** No competing interests were disclosed
Results:
- Why is lemon considered a separate category from citrus? I suggest including all citrus fruit, including lemon as one category.
- In table 1, the results were expressed in a different format, I suggest having all the results expressed as N (%). For this purpose, age can be categorized into 2-3 categories, and same for BMI.
- In the multivariate logistic regression, the authors mentioned that after controlling for covariate, the findings...
  What are the covariates? The authors should list the covariates here, and if that includes controlling for age and gender.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Behavioral neuroscience, cytogenetics, public health research.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 02 Jul 2022

Refat Nimer, Jordan University of Science and Technology, Irbid, Jordan

We would like to thank the reviewers for careful and thorough reading of this manuscript and for the thoughtful comments and constructive suggestions, which helped to improve the quality of this manuscript.

Please find attached a point-by-point response to reviewers’ concerns. We hope that you find our responses satisfactory and that the manuscript is now acceptable for publication.
Reviewer #1 (Comments to the Author):

- Recruitment method is not clear, how the investigators reached out to the potential participants is not stated. The study suggests that only people who were previously infected with COVID-19 were included in the study. This assumption should be discussed in the inclusion criteria.

Authors' response: The recruitment method has now been illustrated in the revised manuscript. In the cover page for the questionnaire, we outlined the criteria for participation in the study, which includes infection with COVID-19 and recovery from illness. The research assistance emphasized that participants' infection should have been confirmed by polymerase chain reaction (PCR). Participants were approached in public places such as bus stations, parks, religious places, universities and restaurants.

- Calculation of the study sample assumed that the total population is the number of COVID-19 infected people as reported by the end of July 2021. Does this report include only adults or total confirmed cases? As the survey targeted only adults, the authors should identify precisely the study population as a reference for sample size calculation.

Authors' response: The sample size for our study was calculated using Raosoft Online Sample Size Calculator (Raosoft Inc., Seattle, WA, USA). 770,712 is the total confirmed cases reported by the end of July 2021, and the recommended sample size was 1067. However, this calculation is to check whether the sample size in our study is sufficient and representative. The number of cases under 18 years of age during the time of sample collection (before the emergence of the Omicron variant) was expected to be small compared to the adult cases (no data available). Therefore, if patients under 18 years are subtracted from the total cases, this would lead to a negligible change in the sample size. Nonetheless, the study sample size was larger than required (n= 2,148) even if child cases are considered. This point is now clarified in the Method section.

- Why is lemon considered a separate category from citrus? I suggest including all citrus fruit, including lemon as one category.

Authors' response: Thank you for your comment. We prefer to keep lemon as a separate category from citrus because some studies showed variations in their nutritional values. This was clarified in the revised manuscript.

- In table 1, the results were expressed in a different format, I suggest having all the results expressed as N (%). For this purpose, age can be categorized into 2-3 categories, and same for BMI.

Authors' response: Done as suggested.

- In the multivariate logistic regression, the authors mentioned that after controlling for covariate, the findings...

What are the covariates? The authors should list the covariates here, and if that includes controlling for age and gender.

Authors' response: The point raised by the reviewer is now incorporated in the revised manuscript.
Competing Interests: No competing interests were disclosed

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