

1 **The Effectiveness of Garlic (*Allium sativum*) Consumption on**
2 **Improving Anosmia and Dysgeusia in Patients with COVID-19**

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Abstract

Background: Coronavirus disease has been declared a pandemic worldwide. Anosmia and dysgeusia are symptoms associated with coronavirus infection. Moreover, there is no effective treatment for coronavirus. Garlic is a well-known herb that has antimicrobial and antiviral properties. This study evaluated the potential therapeutic effect of garlic consumption on reducing the recovery time from anosmia and dysgeusia symptoms among participants with coronavirus-19 infection. **Methods:** A sample of 388 Jordanian participants with coronavirus-19 infection was enrolled in an online computer-assisted web survey during the period from 20th September 2021 to 20th January 2022. The survey consisted of three constructs; sociodemographic profile, symptoms associated with COVID-19, and frequency of garlic and onion consumption used during coronavirus infection. **Results:** The results of this study showed that almost half of the participants were between 20-40 years (193, 49.7%); most of them significantly complaining of fever, fatigue, anosmia, and dysgeusia. Also, most of them used onion (20, 93%) and garlic (29, 23%) to alleviate symptoms of the disease. In total, 40.7% of the participants who used garlic recovered from anosmia within the first 11-15 days followed by 35.3% of participants who recovered within 6-10 days. The results, also revealed that there is no correlation between garlic consumption and recovery from dysgeusia. Hence, there is a weak inverse association between garlic consumption and recovery time from anosmia. **Conclusion:** We suggest that consumption of garlic will enhance the immune system during the fight against COVID-19. There is need for further study to identify the proper amount of garlic consumption to relieve from anosmia during COVID-19.

Key word: Garlic intake, anosmia, dysgeusia, COVID-19

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68 **Introduction**

69 Coronavirus disease (COVID-19) is a disease caused by a new mutation of
70 coronavirus (Wu and McGoogan 2020). Thus, COVID-19 was declared a global
71 pandemic in 2020 (Alam et al. 2021). An interaction between virus COVID-19 and
72 the immune system results in a clinical manifestation (Li et al. 2020; Paces et al.
73 2020) which range from mild influenza symptoms, fever, headache, dry cough,
74 myalgia, fatigue, loss of appetite, Anosmia (loss of smell), and dysgeusia (loss of
75 taste) to severe acute respiratory tract infection (Calder 2020; Li et al. 2020;
76 Moscatelli et al. 2020). Unfortunately, till now there is no treatment to cure COVID-
77 19. As a result, many strategies were adopted to limit the spread of COVID-19 such
78 as: vaccination; social distance; proper nutrition (Murthy, Gomersall, and Fowler
79 2020; Hiedra et al. 2020).

80 Proper nutrition intervention should be at the forefront of the strategies to
81 control spreading of COVID-19 (Alam et al. 2021) due to the cost-effectiveness,
82 safety, and efficiency to enhance the body's immune system (Alam et al. 2021; Hiedra
83 et al. 2020; Murthy, Gomersall, and Fowler 2020). Several recent studies have
84 reported the positive influence of nutritional status and food intake in COVID-19
85 patients (Moscatelli et al. 2020). In this regard, garlic (*Allium sativum*) has been used
86 for therapeutic purposes in many countries (Bayan, Koulivand, and Gorji 2014); also,
87 garlic has anti-viral properties that can be added to the COVID-19 prevention and
88 treatment strategies programs (de Wit and Cook 2014). Garlic contains a variety of
89 minerals such as Ca, Fe, K, Cu, and Mg as well as different vitamins. Moreover,
90 garlic is full of water-soluble organosulfur compounds (Suleria et al. 2015), and rich
91 in various phytochemicals, especially allicin. Allicin has anti-microbial; anti-viral;
92 anti-fungal potential which interacts with the viral phospholipids and amino acids
93 involved in infection that also prevents them from attachment to the host cell by

94 denaturing these viruses (Razavi, Azizolahi, and Rahimi 2006). Even though, many
95 studies have suggested that garlic use could be beneficial in helping the immune
96 system cope better with the viral infection by enhancing the response to viruses,
97 balancing the inflammatory response and it can help prevent immune overreaction to
98 viral infection (Cunningham-Rundles, McNeeley, and Moon 2005). Therefore, to the
99 best of our knowledge, no previous study has been conducted yet to evaluate the
100 effectiveness of garlic consumption on COVID-19 symptoms. This study evaluated
101 the potential therapeutic effect of garlic consumption on reducing the recovery time
102 from anosmia and dysgeusia symptoms among participants with coronavirus-19
103 infection.

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105 **Materials and Methods**

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107 *Study design and participants:* A sample of 388 Jordanian participants with
108 laboratory confirmed COVID -19 infection were enrolled in this online computer-
109 assisted web survey study during the period from 20th September 2021 to 20th
110 January 2022. The sample size was determined using Mendenhall's (1983) equation
111 (Larson 1982). The online self-administered structured questionnaire was constructed
112 in Arabic language using google forms. The link of the questionnaire was distributed
113 using different social media platforms. The inclusion criteria were the following:
114 participants were ≥ 18 years old, laboratory-confirmed COVID-19, clinically be able
115 to fulfill the questionnaire, and without medical history of any respiratory disease.
116 The exclusion criteria were the history of anosmia and dysgeusia before the epidemic
117 as well as the participants who were in the intensive-care unit at the time of the study.

118 *Development of the Questionnaire:* The online questionnaire items were
119 collected from previous research articles about strengthening immune defenses

120 against COVID-19 through nutrition. The questionnaire was divided into four parts:
121 the first part of google questionnaire asked participants to provide written informed
122 consent prior the administration of the questionnaire. The second part includes the
123 demographic profile which consist of multiple-choice questions related to age, sex,
124 and educational level. Whereas self-reported weight and height are provided by open-
125 ended questions. Moreover, in the third part the participants were asked to choose
126 from a list of the symptoms that they had suffered from during their COVID-19
127 infection (dyspnea, fever, headache, fatigue, anosmia, and dysgeusia). Finally, the
128 fourth part the participants were asked to choose from a list of the types of herbs or
129 plants they had used to relieve anosmia and dysgeusia symptoms which include:
130 garlic, onion, lemon, black pepper, Curcuma, ginger, and nutritional supplementation.
131 The questionnaire is expected to take 5 - 10 minutes to fill. The online survey was
132 performed according to the ethical principles of the World Medical Association
133 Declaration of Helsinki.

134 *Data analysis:* Data were extracted as a Microsoft excel spreadsheet then coded
135 and prepared for analysis. Statistical analysis was performed using Statistical Package
136 for the Social Sciences for Windows (SPSS version 22,0; IBM Corp, Armonk, NY,
137 USA). The descriptive analysis is expressed as frequencies, percentages, and
138 numbers. The potential associations between binary or categorical variables have been
139 assessed through cross-tab generation and the Chi-square test. Linear regression
140 analyses were conducted to investigate the association between variables, garlic
141 intake as a dependent variable and anosmia, and dysgeusia as independent variables.
142 On the other hand, certain demographic variables, nutritional supplementation, plants,
143 and herbs were used as adjusting variables. A P value of <0.05 will be considered to
144 be statistically significant in all analyses.

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147 Results:

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149 The sociodemographic characteristics of the study participants in **Table 1** shows that
150 the participants were nearly distributed equally among females (51.5%) and males
151 (48.5%). Almost half of the participants (49.7%) were between the ages of 20 and 40
152 years, and nearly more than half of them (52%.6%) was within an educational level of
153 bachelor's degree.

154 **Figure 1** shows the participants consumption of some common herbs and
155 plants. The results showed that nearly (75%) of the participants used garlic (29.23%),
156 black pepper (24.43%), and onion (20.93%). Furthermore, **Figure 2** shows the
157 distribution of participants according to the common symptoms of COVID-19.
158 Results show that fatigue, fever, anosmia, and dysgeusia were the most common
159 symptoms among the participants (21.3%, 19.3%, 19.9%, and 15.5%, respectively).

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161 **Table 2** shows the association between garlic intake, anosmia, and dysgeusia. The
162 results show a significant but negative and weak correlation between garlic
163 consumption and anosmia ($- 0.313 \pm 0.069$, $p < 0.05$) as well as a significant and very
164 weak correlation between garlic consumption and dysgeusia. Thus, **Figure 3** shows
165 the different recovery times from the anosmia among participants who reported using
166 garlic during COVID-19. 40.7% of the participants recovered from anosmia within
167 the first 11-15 days followed by 35.3% of participants who recovered within 6-10
168 days.

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170 Discussion:

171 The results of this study indicated that the prevalence of confirmed COVID-19
172 infection among 388 participants in this study was substantially higher among
173 younger participants. Also, there is a significantly higher prevalence of anosmia and
174 dysgeusia symptoms among participants, more than half of them used garlic during
175 the COVID-19 infection. Interestingly, the study showed that the recovery time from
176 anosmia symptoms was also significantly reduced among garlic consumers during
177 COVID-19 infection. Moreover, after adjusting of confounding variables, it was
178 found that the association between garlic consumption and recovery time from
179 anosmia among participants were inversely related. Furthermore, the pathological
180 mechanisms leading to anosmia during COVID-19 infection are still unknown. The
181 results of available clinical evaluations indicated that anosmia was the main form of
182 neurological injury in patients with COVID-19 (La Rosa et al. 2020). DNA and RNA
183 of COVID-19 viruses could be directly or indirectly responsible for mild to severe
184 infection of mucosal epithelium in the oral cavity which may lead to ulceration or
185 lesions of the oral tissue (La Rosa et al. 2020). Similarly, only one study worldwide
186 reported hyposmia as a symptom of COVID-19 infection (Mao, Zhang, and Huang
187 2014). The pathological mechanism which supported that some patients had hyposmia
188 during COVID-19 infection suggested that COVID-19 virus may invade CNS through
189 a retrograde neuronal route (Lechien et al. 2020).

190 Garlic (*Allium sativum* L) is a functional food containing a bioactive compound that
191 may be able to pre-exposure and post-exposure prophylaxis which exhibits a role in
192 antimicrobial, antiviral, immunomodulator and antioxidant activities (Sivaram et al.
193 2004; Aly, Atti, and Mohamed 2008). Previous research suggested that the beneficial
194 health properties of garlic are mainly attributed to the bioactive compounds, including
195 Sulphur containing compounds, particularly thiosulfinates, such as: allicin, allin, and

196 diallyl sulfides (Amagase and Milner 1993; Block 1992). Hence, garlic compound
197 may be able to enhance the activity of cytokine suppressors, promotion of lymphocyte
198 synthesis, natural killer cells, and macrophages; also, garlic improves outcomes of
199 COVID -19 by decreasing the inflammation and respiratory symptoms (Mohajer
200 Shojai et al. 2016; Kyo et al. 1998).

201 In a randomized clinical study, garlic extracts have been evaluated for their inhibitory
202 effect on infectious bronchitis virus during replication. Participants were randomly
203 allocated either garlic or placebo during viral infectious bronchitis. It was shown that
204 virus titers in the treatment groups were significantly decreased as compared to the
205 control group (Chen et al. 2014). A similar finding was observed on the inhibitory
206 effect of garlic against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-
207 2) multiplication that suggested a beneficial preventive measure before being infected
208 with the SARS-CoV-2 virus. Garlic decreases the expression of proinflammatory
209 cytokines and reverse the immunological abnormalities to more acceptable levels
210 probably due to the formation blocking of structural proteins and genetic materials
211 (Chen et al. 2006). Several randomized double-blind trials were conducted to assess
212 the effect of garlic supplementation on common cold infections. A randomized
213 control trial was conducted on 146 participants who were allocated to either garlic
214 (180 mg allicin) powder once per day or a placebo group. Self-reported common cold
215 infection was significantly less common in the garlic group as compared to the
216 placebo group. As a result, the severity and duration of common cold symptoms were
217 significantly reduced in the garlic group compared to the placebo (Josling 2001;
218 Lissiman, Bhasale, and Cohen 2012).

219 On the other hand, vaccines are expensive and may not be available against the
220 diseases. Therefore, there is a need for alternative nutritional intervention as one of

221 the efficient strategies to fight against COVID-19. On the whole, the findings of this
222 study indicated that the prevalence of nutritional supplementation intake was
223 significantly higher among participants with COVID-19 infection. Several researchers
224 are focusing on nutrition to control COVID-19 worldwide for its role in the
225 development and maintain the immune system thus alter the susceptibility to infection
226 (Alam et al. 2021; Sasi et al. 2021).

227 This study has several limitations. First, only 388 patients were studied which could
228 cause biases in clinical observation. Therefore, it would be better to include more
229 participants in the study. Second, all data was extracted from the electronic web
230 survey based on the participants self-reported data of COVID– 19 symptoms and
231 intake of supplementation and herbs during the disease.

232 **Conclusion**

233 The results indicating that because of the emergency state, there are numerous
234 effective, safe treatments and preventive measures against COVID-19. Within the scope of
235 preventive measures, garlic may be an acceptable therapeutic measure against COVID-19
236 infection and seems to counteract the symptoms caused by COVID-19 infection. We suggest
237 that the administration of this functional food will enhance the immune system during the
238 fight against COVID-19.

239

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242 conduction of this research.

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244 **Conflict of interest**

245 The authors declare that there are no conflicts of interest.

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247 **Authors' contribution**

248 Baha'a Abu Salma: wrote the paper, conduct research, analyze the data and draft
249 the paper; Hanen Tarawneh and Nizar Al-Rabadi conduct and design the research
250 idea, revision the final content of the paper; Mohammed Omar Ibrahim had primary
251 responsibility to revise the final content of the paper; Ali Ibrahim Elmoumani
252 conducted the research and wrote the paper. All authors read and approved the final
253 version of the paper.

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Table 1: Socio-demographics of the Participants

Items	N (%)
Participants	N = 388
Age	
18 - 20 years	36 (9.3%)
20 - < 40 years	193 (49.7%)
40 - < 60 years	140 (36.1%)
> 60 years	19 (4.9%)
Gender	
Male	188 (48.5%)
Female	200 (51.5%)
Educational level	
≤ Secondary degree	62 (61%)
Diploma degree	35 (9%)
Bachelor degree	204 (52.6%)
Higher education degree	87 (22.4%)
Body mass index (kg/m ²)	
≤ 18.5	29 (7.5%)
18.5- 24.9	146 (37.9%)
25 – 29.9	144 (37.4%)
30 – 34.9	53 (13.8%)
35 - 39.9	8 (2.1%)
≥ 40	5 (1.3%)

Data are expressed as number of replicates (N), and percentage (%).

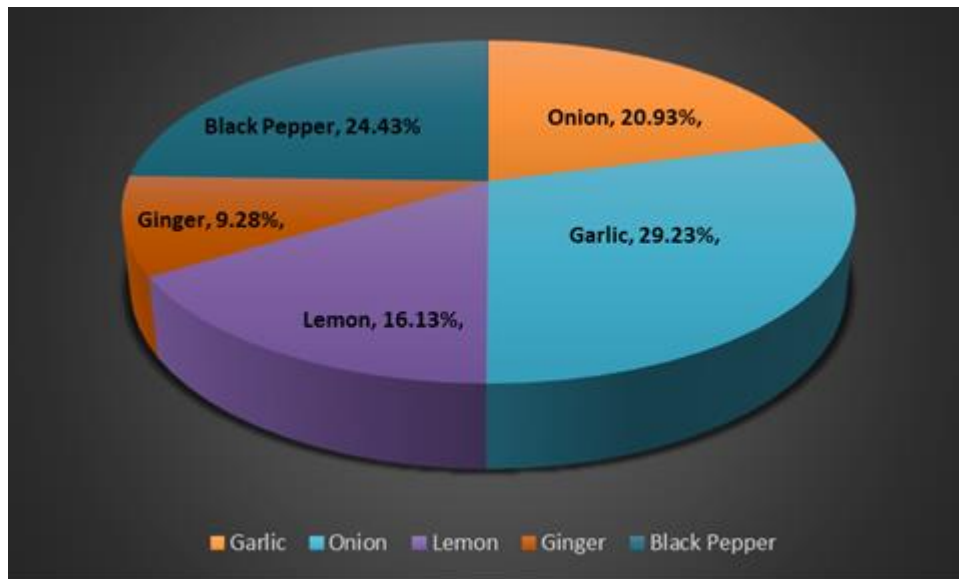


Figure 1: Participants distribution according to the common herbs and plants consumption.

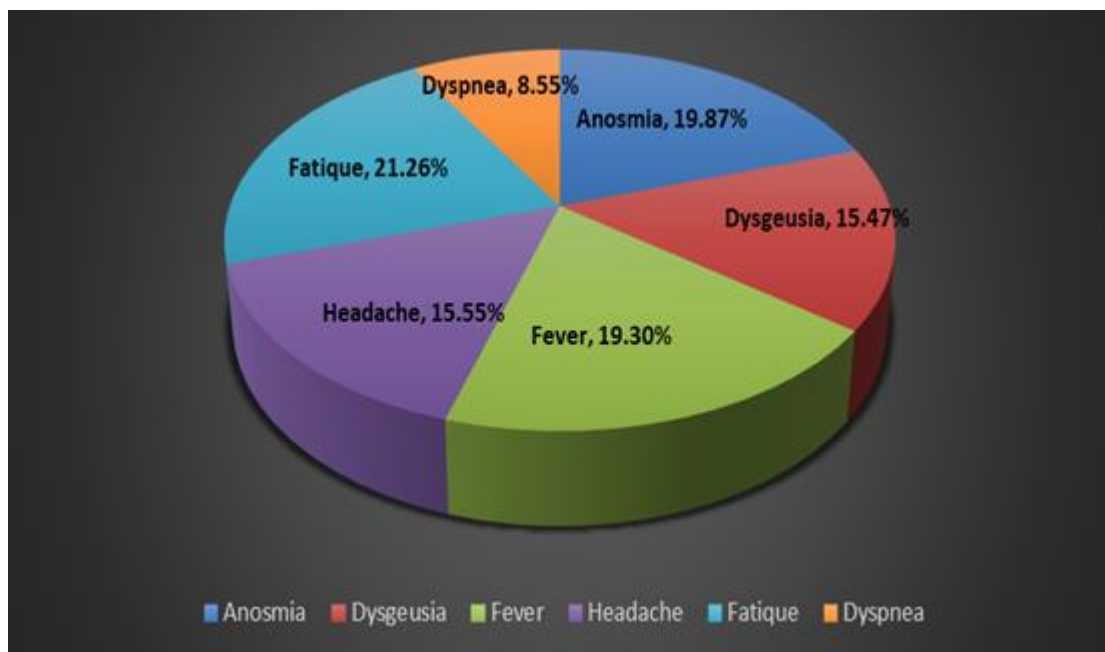


Figure 2: Distribution of participants according to common symptoms of COVID-19.

Table 2: Association between garlic consumption and recovery from anosmia and dysgeusia:

Symptoms	Garlic intake B ± SEM	P- value
Anosmia	- 0.313 ± 0.069	0.001
Dysgeusia	- 0.022 ± 0.006	0.01

Model adjusted for age, sex, vitamin D, vitamin C, lemon, ginger, curcuma, and onion intake.

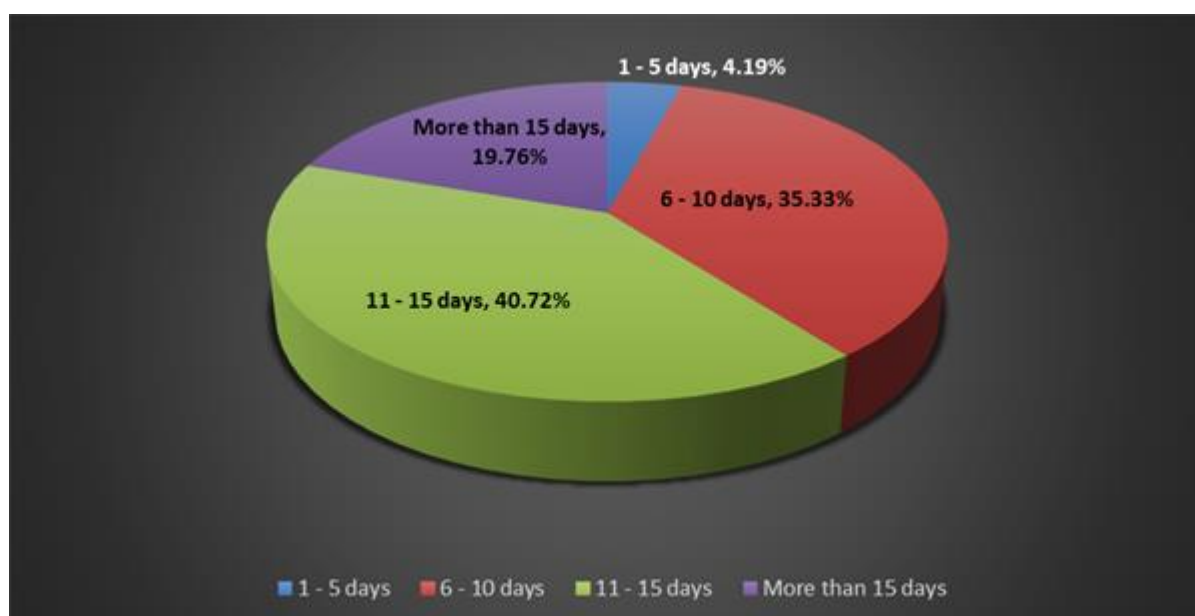


Figure 3: Distribution of participants with Anosmia according to garlic consumption and recovery time