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Beekeeping activities and consumption of beekeeping products by beekeepers under the pandemic conditions*

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Summary

The study was carried out in 2021 to examine infection rates with the new coronavirus (COVID-19), consumption of beekeeping products and beekeeping activities for the beekeepers who are directly exposed to bee venom or the ones who consume different beekeeping products during the pandemic period. At the same time, the rates of beekeepers affected by SARS-CoV-2 infection were also determined. Approximately 90% of the beekeepers (n = 147) who participated in the survey reported that they were not affected by SARS-CoV-2. Those not infected with COVID-19 (n = 134) had been beekeepers for an average of 17.85 years and they went to their apiary once a week (79.1%). They did not apply any treatment against bee stings (80.6%). Their personal honey consumption per month was between 750-1000 g (41.8%) and they consumed the most pollen among other beekeeping products (58.2%). The number of beekeepers who were not infected with COVID-19 was 21 (15.7%) although they contacted family members infected. There were no statistical differences in terms of AB0-blood types between the beekeepers who were infected with SARS-CoV-2, those who were not infected despite close contact the infected family members, and those who were not infected (P > 0.05). Approximately 76% of the beekeepers (n = 147) who participated in the survey and 53% of the beekeepers (n = 13) infected with the SARS-CoV-2 stated that their beekeeping activities were not affected by the pandemic. During the pandemic, the products most demanded by consumers from these beekeepers were honey, pollen and propolis, respectively. This study revealed that the beekeeping activities and the consumption habits of beekeeping products by the beekeepers during the pandemic were not affected.

Keywords: beekeeping, products, COVID-19, pandemic, beekeepers' health

Beekeeping is an important animal production activity that provides economic income and healthy nutrition support to beekeepers' families with various valuable products. The contribution of honeybees to natural life in the places where beekeeping activities are carried out is also more important than its economic value. After the announcement of the COVID-19 pandemic, which affected the whole world, people tended to strengthen their immune systems by consuming natural or fortified foods, in addition to paying attention to hygiene rules and social distance. In this context, different beekeeping products such as honey, propolis and bee venom, which have been used in apitherapy for years due to their remarkable pharmacological properties, were also included in the research.

There are numerous studies reporting that various honeybee products such as honey, pollen, propolis, royal jelly, beeswax and bee venom show strong antiviral activity against pathogens that cause severe respiratory syndromes, and that these products also have immune-enhancing effects. These studies have been summarized by many researchers and their suggestions have been presented (1-3, 5, 8, 13, 14, 20). It was frequently seen in the outputs of these studies that beekeeping products have strong antiviral activity and immune system strengthening effects against pathogens that cause severe respiratory tract syndromes. It was reported in a survey of 5115 beekeepers in the

* The study was approved by the ethics committee of the University of Harran on December 9th, 2020 (registration number 14/12/2020-E.49104).

Hubei province of China that no beekeeper showed symptoms of COVID-19, in addition, none of the 121 people treated with bee venom in an apitherapy clinic were infected with SARS-CoV-2 (25). Based on this report, in a survey of beekeepers in Germany (n = 234) it was reported that ninety-nine beekeepers were not infected with SARS-CoV-2 despite their close contact with children or spouses infected. Furthermore, two beekeepers died from SARS-CoV-2, and forty-five were infected. Nevertheless, the findings of the survey do not prove the hypothesis that beekeepers were not infected by COVID-19 because of their exposure to bee stings and the related immunity (15).

The point of departure for this study was the feedback of the beekeepers who were not infected with the SARS-CoV-2 despite there being a person infected in their households in the first period of the pandemic in the study area. This study aimed to determine the infection rates with new coronavirus (COVID-19), the consumption of beekeeping products, and beekeeping activities during the pandemic period for the beekeepers who are directly exposed to bee venom or who consume different beekeeping products. At the same time, the aim is to examine the relationships between beekeepers' habits in consumption of beekeeping products and their health status related to COVID-19. Thus, it will be determined whether both the beekeepers consuming beekeeping products with antiviral or immunomodulatory effects and the ones being exposed to bee venom are affected by the infection. It is emphasized that the study covers a period between the start of vaccination and the emergence of different variants of the coronavirus.

Material and methods

The study was carried out throughout the province of Adıyaman, which has 924 apiaries. 664,709 tons of honeys are produced in a total of 65343 beehives (https://biruni.tuik.gov.tr/medas/?kn=101&locale=tr.) in Adıyaman province, located in the southeast of Turkey. A survey of 32 questions was conducted to beekeepers to determine the structure of their beekeeping activities, production quantities, demographic information, and cases of catching COVID-19, frequency of exposure to bee venom and consumption habits of beekeeping product. The survey was conducted by telephone and face-to-face with 147 randomly selected beekeepers who could be reached, between January and June 2021 under pandemic conditions. The number of beekeepers to be surveyed was determined by the proportional sampling method using the formula below (16). The questionnaire data were analyzed with SPSS v21 package program.

$$n = \frac{N * p * q}{(N-1) * \sigma_p^2 + p * q} = \frac{924 * 0.5 * 0.5}{(924-1) * (0.001507) + 0.5 * 0.5} \cong 141$$

$$\sigma_p^2 = \left(\frac{r}{Z\alpha_{/2}}\right)^2 = \left(\frac{0.1}{2.5758}\right)^2 = 0.001507$$

Tab. 1. Demographic information of beekeepers participating in the survey

Demographic information	General (n = 147)	SARS-CoV-2 (+) (n = 13)
Age (mean)	48.98	50.69
min	25	26
max	74	73
Education (%)		
primary	50.30	69.2
high school	21.80	15.4
associate/undergraduate	21.10	15.4
Gender/Male (%)	99	100
Blood type (%)		
0 RH (+)	32.00	30.8
A RH (+)	31.30	23.1
B RH (+)	16.30	23.1
AB RH (+)	10.90	15.4
Number of households (mean)	5.50	5.62
min	1	2
max	18	9

Results and discussion

The average age of the beekeepers participating in the survey was 48.98 years. 50.30% of beekeepers were primary school graduates. The average number of people living in the same household was 5.5. There was one female beekeeper, and the blood group distributions of the beekeepers were also given in Table 1.

74.8% of the beekeepers participating in the survey were migratory beekeepers, and the average number of beehives was 83.37. Beekeeping was an additional

Tab. 2. Beekeeping activities of beekeepers

Beekeeping activities	General (n = 147)	SARS-CoV-2 (+) (n = 13)
Stationary (%)	25.20	23.10
Migratory (%)	74.80	76.90
Association memberships (%)	83.70	100
The number of beehives (mean)	83.37	128.54
min	2.0	20
max	760	760
Beekeeping experience (year) (mean)	17.91	18.54
Economic purposes (%)		
main source of income	25.9	23.10
additional source of income	69.4	69.2
hobby	4.80	7.70
Commercial purposes (%)		
honey production	91.20	92.30
Apiary visits (%)		
every 0-7 days	79.60	84.60
every 7-14 days	19.00	15.40

source of income (69.4%) for the beekeepers, and honey was the main product produced for commercial purposes (91.2%). 79.6% of beekeepers visited to the apiary once a week for colony controls (Tab. 2).

The exposure to bee venom from the beekeepers was also examined. The beekeepers stated that they had 2-4 (59.9%) bee stings in each apiary visit, they were not allergic reactions to bee venom (96.6%), and they also did not do any treatment against bee stings (77.6%). 30.8% of the beekeepers infected with SARS-CoV-2 (+) stated that they applied cold treatment against bee stings (Tab. 3).

The consumption quantities and habits of beekeeping products of the beekeepers were also examined. Although the personal honey consumption of the beekeepers per month was 750-1000 g (42.2%), it was determined that the monthly honey consumption amounts of 13 beekeepers infected with COVID-19 were higher. At the same time, 69.2% of the beekeepers infected with COVID-19 reported that they consumed honey as a dietary supplement during the treatment. Among beekeeping products apart from honey, pollen consumption was prominent (57.1%). There were also the beekeepers who did not consume any beekeeping products other than honey (18.4%). Although propolis was consumed by the beekeepers during the pandemic (42.9%), it was determined that regular consumption of beekeeping products other than honey was low (38.1%) and the rate of the beekeepers who did not answer this question was 83.7% (Tab. 4).

76.2% of the beekeepers participating in the survey (n = 147) and 53.8% of the beekeepers infected with COVID-19 (n = 13) stated that the pandemic period did not restrict their beekeeping activities. The most demanded products by consumers from beekeepers during pandemic were honey, pollen, and propolis respectively. The average honey yield per colony was reported as 10.41 kg and 7.61 kg for 2019 and 2020, respectively.

The beekeepers who were not infected by coronavirus. 90.47% of the beekeepers reported that they were not infected with COVID-19. Those not infected with COVID-19 (n = 134) reported that they had been beekeepers for an average of 17.85 years, and they went to their apiary once a week (79.1%). The average age of these beekeepers was 48.81 years. An average of 5.54 people lives in the household. These beekeepers were exposed to 2-4 bee stings every apiary visit (60.4%). They did not apply any treatment against bee stings (80.6%). Their monthly personal honey consumption was between 750-1000 g (41.8%), and they consumed pollen the most among other beekeeping products (58.2%). Among these beekeepers, the rate of those who consumed propolis during pandemic period was 42.5% and the rate of those who regularly consume other beekeeping products other than honey was 38.8%.

Tab. 3. Exposure of beekeepers to bee venom

Exposure to bee venom	General (n = 147)	SARS-CoV-2 (+) (n = 13)
The number bee stings (%)		
2-4 pieces	59.90	53.8
4-6 pieces	18.40	15.4
6 pieces and over	11.60	15.4
Bee venom allergy (no,%)	96.60	84.6
Treat against bee stings		
no treat (%)	77.60	46.2
cold (%)	15.60	30.8

Tab. 4. Consumption habits of beekeeping products of the beekeepers

Consumption habits	General (n = 147)	SARS-CoV-2 (+) (n = 13)
Honey consumption (monthly) (%)		
750-1000 g	42.20	46.2
250-500 g	27.10	46.2
500-750 g	23.10	–
Other beekeeping products consumption (%)		
pollen	57.10	46.2
propolis	19.70	38.5
none	18.40	15.4
Propolis consumption during pandemic (%)		
yes	42.90	46.2
no	57.10	53.8
Other beekeeping products consumption pattern (%)		
irregular	45.60	61.5
unanswered	83.70	7.70
regular	38.10	30.8

Beekeepers who contact family members infected with COVID-19. The number of beekeepers who were not infected with COVID-19 was 21 (15.7%) although they contacted with infected family members. Nine of the beekeepers infected with COVID-19 (+) (n = 13) said that their family members were also infected. The rate for family members infected with COVID-19 other than the beekeeper was found as 20.4% (n = 147). These beekeepers, who were not infected with COVID-19 despite being in contact, visited the apiary once a week (81%) and were exposed to an average of 2-4 bee stings (66.7%) in each apiary visit. They did not do any treatment against bee stings (76.2%). Their monthly personal honey consumption was between 500-750 g (33.3%), and they consumed the most pollen (71.4%) among other beekeeping products. Among these beekeepers, the rate of those who consume propolis during pandemic period was 66.7% and the rate of those who regularly consume other beekeeping

products other than honey was 42.9%. It was reported that the family members infected with COVID-19 of these beekeepers were not exposed to bee venom before (81%). Also, the rate of those who said that their family members who were not infected with COVID-19 were exposed to bee venom was 52.4%.

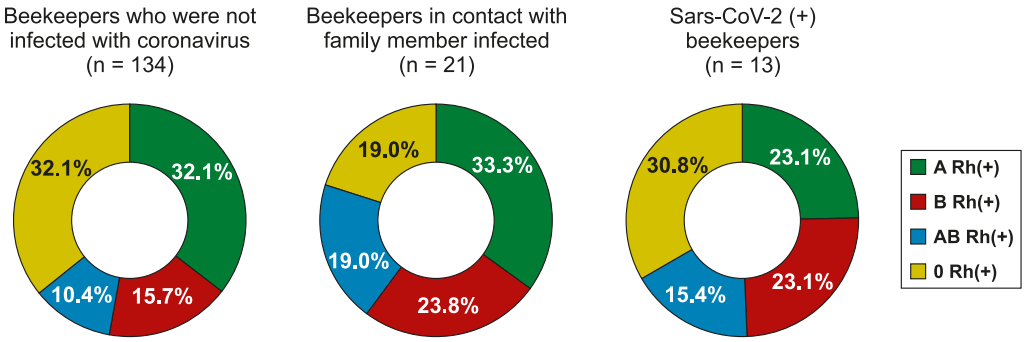

Fig. 1. AB0-blood types distributions of beekeepers (%)

Blood types of the beekeepers. There were no statistical differences in terms of AB0-blood types between the beekeepers who were infected with SARS-CoV-2, those who were not infected despite close contact within the family members infected and those who were not infected ($P > 0.05$). Therefore, it was found that AB0 blood groups had no effect on infection according to the distribution of blood types of the beekeepers in the survey sample (Fig. 1).

Only one of 13 beekeepers infected with COVID-19 (+) stated that he had 0 Rh (–) blood type. The beekeepers who were not infected with coronavirus reported that 3.7% had A Rh (–) and 6% had 0 Rh (–) blood type (n = 134).

The relationships between beekeepers' habits in consumption of beekeeping products and the situations of those infected with COVID-19, those not infected with COVID-19, and those who have not had COVID-19 despite being in contact at home have been examined. Among these three groups of beekeepers, the propolis consumption rate of the beekeepers who did not have COVID-19 despite being in contact at home was found to be higher than the others. It was also studied whether there was a difference between the propolis consumption of beekeepers in two groups, the beekeepers with COVID-19 (+) and those contacting with COVID-19 infected patients in one group and those non-infected in another group. The propolis consumption of group beekeepers with COVID-19 (+) and those contacted with COVID-19 infected patients was higher (64.5%) and the chi-square test statistic was found to be significant ($\chi^2 = 6.922$, $P = 0.009$). This difference in the use of propolis by the beekeepers contacting infected family members at home and those with COVID-19 (+) is remarkable. It is recommended to examine the effect of propolis in other studies in detail on avoiding infection or recovering from it. On the other hand, there was no significant relationship between beekeeper groups in terms of consuming other beekeeping products such as honey, pollen, and royal jelly.

At the beginning of the pandemic, which affected all professional groups, it made a difference that the restrictions were regulated in such a way as not to affect the activities of beekeepers, but the average age of beekeepers in our country was particularly high (11, 17, 23). And so, beekeepers over the age of 65 needed supports for colony care (18). It was also reported that the ongoing COVID-19 pandemic had various and negative effects on beekeeping research at the global level (9). The average age of the beekeepers in three different groups was similar and the effect on their health status was insignificant in this study ($P > 0.05$). 76.2% of the beekeepers (n = 147) and 53.8% of the beekeepers who were infected with COVID-19 (n = 13) stated that the pandemic period did not restrict their beekeeping activities in this study. On the other hand, it was emphasized in other studies (6, 10) that beekeeping activities were disrupted during the pandemic period and the economic importance of this result not only for the beekeepers or their employees but also for pollination services.

Since the emergence of COVID-19, the associations between AB0-blood types and infection have been examined in many studies. It was reported that blood type 0 appears to be associated with a lower risk of COVID-19 although there was variation between studies (19, 26, 27). In this study, it was found that there were no statistical differences in terms of AB0-blood types among the beekeepers who were infected with SARS-CoV-2, those who were not infected despite close contact with the family members infected and those who were not infected. We therefore could not establish a strong correlation between blood types and the health status of beekeepers regarding SARS-CoV-2 infection in our study.

The antiviral activities, as well as many other features of beekeeping products, have been explained in detail in the light of many studies, but new research is still needed. Propolis, bee venom, honey, royal jelly, pollen, and beeswax were listed from high to low in terms of antiviral activities of beekeeping products (https://www.bee-hexagon.net/). Within the scope of this study, the propolis consumption of the beekeepers was examined and it was also examined whether they need to consume propolis especially during the pandemic period. The beekeepers reported that they consumed 42.9% of propolis although not regularly. The reason for this may be that propolis is not a ready-to-eat supplement and a beekeeper must purchase it commercially. According to the study result, honey

consumption was primarily among beekeepers and pollen consumption came second in beekeeping products. Although beekeepers have a chance to be exposed to bee venom, they wear protective clothing. It was determined that there was no difference among the participating beekeepers in terms of exposure to bee stings to those who were infected with COVID-19 (n = 13), but there were those who applied cold after bee stings (30%). Cold application is known to reduce aches and pains. Among the numerous studies on bee venom and its use in health, it has been suggested that bee venom may be a potential complementary candidate for viral infections (13, 24). According to this study, it was found that the number of beekeepers who were not infected with COVID-19 was 21 (15.7%) although they contacted with infected family members. In addition, 13 beekeepers were infected with COVID-19 (+) and then they recovered. The propolis consumption rates of these beekeepers are high. Propolis is used in complementary medicine due to its immunomodulatory, antimicrobial, antiviral, antioxidant, anti-inflammatory, anti-parasitic, and hepatoprotective properties. Its broad-spectrum antiviral activity has also been demonstrated in various clinical and experimental studies (4, 5, 21, 22). It has been reported that many beekeepers use beekeeping products for the prevention of coronavirus disease (15). As a result, it was determined that 90.47% of the beekeepers who participated in the survey were not infected with COVID-19 (n = 147) and they were able to continue their beekeeping activities including migratory beekeeping (74.8%) despite the pandemic.

Honey bees are one of the important insects in human food production as more than one-third of the food consumed by humans is pollinated by honeybees (12). Beekeeping products and beekeeping activities are becoming more and more important in terms of economic, ecological, and human health. This study revealed that the beekeeping activities and the consumption habits of beekeeping products by the beekeepers during the pandemic were not affected.

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