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Properties of some bee products (pollen, roe milk and bee venom), apitherapy and their effects on Covid-19

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Abstract

The new type of coronavirus infection (COVID-19), caused by coronavirus-2 (SARS-CoV-2), has led to a world pandemic due to severe acute respiratory syndrome. In addition to drug and vaccine studies for COVID-19, studies on various foods maintain to increase immunity and alternative treatment, and in this context, bee products are also being researched. Although many studies are showing that bee products have antimicrobial properties and immune-enhancing effects, there are limited studies on the effectiveness of these products against coronavirus. Some peptides in royal jelly are reported to be potent antibacterial and antifungal agents that may be beneficial for avoiding co-infections in COVID-19 patients. Positive results have been found Pollen, a fine and powder-like substance produced by flowering plants and collected by bees, in many studies investigating the effects of pollen on health such as antimicrobial, antiviral and anti-inflammatory. Bee venom; It is a yellowish-colored, bitter-sweet, pungent-smelling substance that is produced in the venom sac of bees, normally in liquid form, but dries up and crystallizes after contact with air. Melittin, the primary component of bee venom having more than 40 biologically and pharmacologically active compounds including phospholipase A2, histamine, epinephrine, free amino acids, peptide and apamin, has been stated to have antitumor, antimicrobial, anti-nociceptive and anti-inflammatory activities. Phospholipase A2 (PLA2) secreted from bee and snake venom is known to have strong anti-HIV activities. Melittin, phosphorylase A2 and hyaluronidan, which are the most significant components of bee venom, constitute 50% of bee venom. Moreover, researches on the relationship between bee venom and COVID-19 are limited. The target of this review is to bring together the studies on the health effects of royal jelly, bee pollen and bee venom, and to contribute to the existing studies.

Keywords: Royal jelly; Bee pollen; Bee venom; COVİD-19

1. Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by coronavirus. Coronavirus is a non-segmented, single-stranded and broad-enveloped virus. The coronavirus (SARS-COV-2) that causes upper respiratory tract infection and it has many different symptoms. Diseases such as fever, headache, weakness, sputum, hypogeusia, sore throat, dyspnea, cough, diarrhea, anorexia, dizziness, rhinorrhea, nasal congestion, hyposmia and myalgia are examples of these symptoms [1]. There are seven different types of coronavirus known to infect humans, called the human coronavirus (CoVh). Two of them are alpha-coronavirus (229E and NL63) and five are beta coronavirus (OC43, HKU1, SARS-CoV, SARS-CoV-2 and MERS-CoV) [2, 3]. It has been reported that the coronavirus can be transmitted to humans by virus-laden droplets, aerosol micro particles, or asymptomatic infection and mainly affects the lungs in humans [4]. Three different outbreaks caused by the human coronavirus have been reported. One of them is SARS-CoV, acute and severe

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respiratory syndrome, originated in 2002 in China. The second epidemic, known as MERS-CoV in the Middle East, started in Saudi Arabia in 2012, again with symptoms of respiratory tract syndrome. The latest outbreak emerged as the COVID-19 pandemic (SARS-CoV-2), first reported in December 2019. The first case of the latest outbreak emerged in Wuhan city of China's Hubei province and was reported as the new coronavirus of 2019 (2019-nCov). It has been stated that this virus is associated with a beta-coronavirus and it has been reported that its symptoms begin with similarity to pneumonia. Later, the International Virus Taxonomic Committee named 2019-nCov as SARS-CoV-2, since the 2019-nCov genome sequence was 89% similar to SARS-CoV [5]. SARS-CoV-2 is transmitted by salivary droplets or nasal discharge when infected patients cough or sneeze [6].

COVID-19 proceeds to spread among people around the world and has become an international problem. Moreover, even after a decade of study on the coronavirus outbreak that had already occurred, it seems that there are still no licensed vaccines or therapeutic drugs to avoid and treat coronavirus infection [5].

Due to the rapid spread of the current COVID-19 pandemic and the long time necessary for vaccine development and drug discovery, there is an urgent requirement for prevention and treatment strategies against COVID-19 based on natural products. Various natural products have been extensively researched and used as potential treatment options for several types of infections. Among them, honey is a bee product and has been attracting the attention of researchers for a long time as a complementary and alternative medicine product [7].

So far, it has been discovered that bee products have varied biological, therapeutic, nutraceutical and pharmaceutical properties [8, 9].

Apitherapy is a category of complementary and alternative medicine that contains the therapeutic use of different bee products, including apilarnil (atomized drone larva), to prevent and treat diseases [10].

Figure 1 Schematic representation of the main effects of bee products that can be used against the novel coronavirus (SARS-CoV-2)

According to another definition, apitherapy is defined as the science and art of using the products obtained from the honey bee hive to maintain health and prevent diseases [11]. Apitherapy, which provides treatment based on honey and other bee products against many illnesses, has been improved as an alternative medicine branch [12]. In fact, it is known that apitherapy (the use of products produced by honey bees such as pollen, honey, royal jelly, propolis and bee venom for therapeutic and pharmacological purposes) was applied by the Egyptians. In recent years, countries such as New Zealand and Australia have adopted the use of honeybee products for wound treatment. Scientists have conducted both in vivo and clinical studies and research in the treatment of diseases with honey. According to these researchers, they found honey to be useful as a wound dressing through multiple mechanisms, such as an antimicrobial agent, a debrider, and an anti-inflammatory agent. In addition, it has been assumed that honey has a positive effect on reducing edema and scarring in the wound, and it has been reported to potentially accelerate and facilitate the healing of epithelial tissues [13].

Apitherapy, as an alternative medicine product in which the field of pharmacology is combined with nutraceutical agents, is also thought to be promising for the treatment process and prophylaxis of COVID-19 [5]. In previous studies; it has been reported that different honey products such as honey, pollen, propolis, royal jelly and beeswax have strong antiviral activity against pathogens such as CoVh, which cause severe respiratory syndromes [14;15]. The benefits of these natural bee products to the immune system draw attention, and it is stated that most of them play an important role in the induction of antibody production, maturation of immune cells, and stimulation of innate and adaptive immune responses [16] (Figure 1).

In this review, some physicochemical properties and components of bee products such as pollen, royal jelly and bee venom, and the use of these products as an alternative in the COVID-19 epidemic, which continues to be a great and widespread danger to the world, causing various respiratory diseases and even death, are discussed. It is aimed to bring together various in vivo, *in vitro* and clinical studies.

2. Royal Jelly and Covid-19

Royal jelly is a substance secreted and obtained from the hypopharyngeal and mandibular glands of worker bees (5 -14 days old) (*Apis mellifera L.*). It is a thick, milky-white liquid that is the food of all bee larvae and the queen bee until death (Figure 2) [17].

Figure 2 The structure of royal jelly

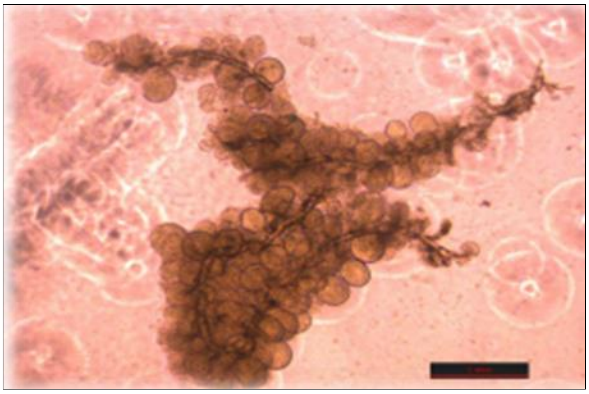

Figure 3 Light microscope image of the hypopharyngeal gland

Hypopharyngeal gland (hpg) and Mandibular gland (mbg) play an important role in the production of royal jelly. Royal jelly secretion by the hpg and mbg gland varies according to the age of the worker bees [18]. Mbg is a double sac-like gland found only in queen and worker bees. It is located on both sides of the head, just above the jaws [19]. Hpg is located in the front of the worker bee's head and has a long bi-nodular structure (Figure 3). It has a structure similar to many small sacs called acini (secretory gland) consisting of secretory cells [20]. The size of the glands begins to increase on the 6th day after hatching and plays an important role in the formation of royal jelly. However, the color changing from cream to pale yellow after the 15^{th} day significantly reduces this Liu situation [21, 22]

After hatching, the larvae, which are intended to be workers, are fed with a mixture of royal jelly, honey and pollen [17]. After a 3-day larval development period in which both worker and queen larvae are fed royal jelly, worker larvae are fed a combination of worker gel, pollen and honey, while queen larvae receive copious amounts of royal jelly from worker bees [23, 22]. The essential nutrients in royal jelly and the duration of feeding with it determine that female larvae will develop into short-lived infertile worker bees or long-lived fertile queen bees [24].

While worker bees have a life span of about six to eight weeks, the queen bee, who is constantly fed royal jelly, is known to have a productive life span of up to four to five years. Although queen and worker bees are genetically identical, they differ greatly in their phenotypic, physiological and functional characteristics. Thus, royal jelly appears to have a strong epigenetic effect on the differentiation of worker and queen subpopulations of larvae. This is thought to be achieved through epigenetic modification to DNA as well as regulation of gene transfer [25].

The composition of royal jelly, which is rich in proteins, carbohydrates and lipids [26], contains water (50%-60%), proteins (18%), carbohydrates (15%), lipids (3%-6%), mineral substances (1.5%) and vitamins [27]. About 185 organic compounds have been detected in royal jelly. Royalactin has been reported to be the most important protein in royal jelly. In addition, royal jelly consists of a significant number of bioactive compounds, including 10-hydroxy-2-decenoic acid (HAD), which has some immunomodulatory properties [28]. Fatty acid, proteins, adenosine monophosphate (AMP) N1 oxide, adenosine, acetylcholine, polyphenols and hormones such as testosterone, progesterone, prolactin and estradiol are other beneficial bioactive components reported to be present in royal jelly [29].

Phytosterols are an important lipid component of royal jelly because all insects are sterol auxotrophs and must obtain phytosterols through their food sources [30]. In honey bees, phytosterols are important for molting hormone production, stability of insect cellular membranes, and other vital physiological processes [31]. Studies have reported the presence of 24-methylenecholesterol, D5 avenasterol, b-sitosterol and desmosterol in royal jelly [32, 33, 34]. It has been reported that other metabolites, amino acids, lipids, and phytochemicals contribute to honey bee nutrition [35, 36], epigenetic effects of royal jelly [37] and antimicrobial properties [38].

With royal jelly synthesized by worker bees, the possibility of pesticide contamination to the developing queen larvae is low. In the risk assessment guide of the United States Environmental Protection Agency (USEPA), it has been reported that pesticide exposure is approximately 100 times less in royal jelly compared to pollen and nectar [39]. Different studies measuring the transfer of xenobiotics from pollen to royal jelly, including pesticides, support this result and found that xenobiotics are almost completely buffered by worker bees [40, 41, 42].

Royal jelly proteins play an important nutritional role in the growth of larvae [43, 44]. The lipid fraction of royal jelly is synthesized by the salivary glands of worker bees [45] and consists largely of organic fatty acids, mainly 10-hydroxy-2-decenoic acid (10 HDA) [46]. Considering its biological properties, it is stated that royal jelly has important commercial value and is used in many sectors from the pharmaceutical and food industries to the cosmetics and manufacturing sectors [26]. In addition, royal jelly is used for feeding larvae and adult queens [47].

Studies indicate that royal jelly obtained directly or purified has an important antimicrobial activity. It has been reported that the use of royal jelly alone or in combination with propolis reduces the *in vitro* viral load of influenza virus A2-infected cells [48]. Also, clinical studies show that the combination of royal jelly with other honeybee products prevents infection during flu epidemics. Since the combination of bee products has been evaluated in the prophylaxis of viral respiratory diseases, the understanding of the effect of royal jelly is limited [5].

Royal jelly is a functional food with antimicrobial, anti-aging, antioxidant and immunomodulatory effects as well as positive effects on diabetes, cancer, Alzheimer's and cardiovascular diseases [49]. It has been reported that these activities are related to various royal jelly functional components, especially protein, lipid, carbohydrate, vitamin and mineral [47]. It has been stated that most of the royal jelly proteins (about 90%) are water-soluble and have many physiological functions [50, 51]. Purified queen royal jelly proteins (MRJPs) of *Apis mellifera* have been reported to have potent antiviral activity against the RNA viruses HCV (Hepatitis C Virus) and HIV (Human Immunodeficiency Virus) [52, 53].

In addition to the antiviral effect of royal jelly, it can also be used prophylactically due to its benefits to the immune system. An in vivo study reported a higher antibody production and immunocompetent cell proliferation among animals supplemented with royal jelly (0.1 mL royal jelly for up to 7 days) [54]. These results highlight the therapeutic and prophylactic potential of royal jelly and its components against respiratory syndromes, which is one of the important problems in SARS-CoV-2. Importantly, some peptides in royal jelly are reported to be potent antibacterial and antifungal agents that may be useful for avoiding co-infections in COVID-19 patients.

In their study, Habashy and Abu-Serie (2020) investigated the predicted anti-SARS-CoV-2 effect of major royal jelly protein (MRJP) 2 and MRJP2 isoform X1, which have recently shown high activity against other enveloped RNA viruses (HCV and 31HIV). Some in-silico analyzes were performed to predict the effect of these proteins on viral entry, replication and complications, and they indicated that these proteins have a high potential for hydrolysis of sialic acid from the surface of lung cells (WI-38). In addition, it was reported in the study that major royal jelly proteins (MRJP), SARS-CoV-2 could exert an inhibitory effect for nonstructural proteins (main and papain proteases, RNA replicase, RNA-dependent RNA polymerase, and methyltransferase) through a different mechanism. In addition, it has been stated that proteins can bind to hemoglobin binding sites on viral-nsps and thus may be a promising treatment for the prevention of MRJP2 and MRJP2 X1, SARS-CoV-2 infection, which can accompany hemoglobin.

It has been stated that royal jelly proteins are able to bind to the active site on viral nsp3, nsp5, nsp9, nsp12 and nsp16 or to their binding sites as cofactors, thereby inhibiting their activities. In addition, these proteins have been found to be able to prevent viral complications in the lung, such as hypoxia and pathogenesis, due to their ability to actively bind to most of the oxy- and deoxyhemoglobin binding sites on the viral nsps. Therefore, it is stated that MRJP2 and MRJP2 isoform X1 are a promising way to curb this deadly virus that is spreading at an alarming rate. However, further studies such as clinical studies on viruses and *in vitro* tests on proteins are important to confirm these predicted mechanisms [55].

According to [56] investigated the antiviral activities of honey, royal jelly and acyclovir against HSV-1 (Herpes simplex virus type 1). As a result of the study, it was determined that the mentioned natural products did not have harmful effects in laboratory conditions, and they stated that these products could be considered as an alternative to acyclovir in the treatment of herpetic lesions. However, it has been reported that the studies are not sufficient to determine the effectiveness of honey and its products, therefore further studies are required.

The bacterial species most commonly associated with COVID-19 is Mycoplasma pneumoniae, followed by Pseudomonas aeruginosa, Haemophilus influenzae, and Klebsiella pneumoniae. In addition, it is stated that some fungal pathogens such as Candida albicans, Aspergillus flavus, Aspergillus fumigatus and Candida glabrata have been detected in patients infected with SARS-CoV-2 [57]. It is reported that royal jelly shows high activity against K. pneumoniae, P. aeruginosa and C. albicans *in vitro* [58]. Lansbury et al. (2020) recommend the benefits of royal jelly in preventing co-infections, as improvement has been observed in patients hospitalized with COVID-19.

3. BEE pollen and COVID-19

Pollen is a fine, powder-like substance produced by flowering plants and collected by bees. Pollens are the male reproductive cells of flowers. Flower pollen, which is the "primary food source of bees", is rich in carotenoids, flavonoids and phytosterols, but contains different concentrations of phytochemicals and nutrients [59]. In other words, pollen is a diverse plant product rich in active biological substances. It was stated that approximately 200 substances were found in pollen grains obtained from different plant species. The basic chemicals group includes proteins, amino acids, carbohydrates, lipids and fatty acids, phenolic compounds, enzymes and coenzymes, vitamins and bio elements [60].

Bee pollen consists of plant pollen combined with nectar or bee saliva. Therefore, since it contains a wide variety of secondary plant metabolites such as thiamine, tocopherol, biotin, niacin, folic acid, polyphenols, carotenoid pigments, phytosterols and enzymes, it has been used as a medicine for thousands of years, similar to other bee products [14]. There are studies reporting that the antimicrobial activity and phytochemical composition of bee pollen vary according to its geographical and botanical source [61, 62, 63]. The antibacterial activity of bee pollen extracts is thought to be due to the presence of polyphenols (3-5%) and phenolic acids (0.19%) in the pollen, depending on its origin. Various studies have shown that the antibacterial activity of pollen is correlated with the level of phenolic compounds such as kaempferol 2-O-ramnoside, quercetin 3-O-glucoside, isorhamnetin 3-Oxylosyl (1-6) glucoside, and 7-O-methylherbacetin3-O-xylosyl-8-O-galactoside [64, 65, 66]. The *in vitro* antimicrobial activity of bee pollen has been reported to be against a broad spectrum of both antibiotic-sensitive and antibiotic-resistant bacteria and molds [67].

[68], investigated the antimicrobial, antimutagenic, antioxidant and anti-inflammatory properties of the biological activities of commercial bee pollen. As a result of the study, they reported that all bee pollen samples have a significant antimicrobial activity against gram-positive bacteria, which are the most sensitive, and at the same time, the results

obtained show that bee pollen has a good antioxidant activity, so that it can be useful in the prevention of many diseases caused by free radicals.

It has been stated that bee pollen has a series of effects such as antifungal, antimicrobial, antiviral, anti-inflammatory, immunostimulating and local analgesic, and is also used in apitherapeutic treatment because it facilitates the granulation process of the healing of burn wounds [63, 69].

[70] Evaluated the activities of volatile unsaturated fatty acid esters (USFAE) and flavonoids from palm pollen (DPP) as anti-breast cancer and antiviral agents in a culture of Trichoderma koningii. As a result of the study, they determined that the flavonoid content of unfermented palm pollen (FDPP) extract was higher than the flavonoid content of DPP extract. It was also stated that the antioxidant activity of the FDPP extract, which was determined by ABTS, FRAP and DPPH experiments, was higher than that of the DPP extract. Thus, FDPP extract has been reported to show stronger anticancer activity against the MCF-7 cell line (IC50: 9.52 μg/ml) compared to DPP extract (IC50: 96.22 μg/ml). In addition, FDPP extract has also been noted to have potent antiviral activity (CC50: 16.5 μg/ml) compared to DPP (CC50: 38.8 μg/ml). [71], evaluated the effects of pollen, propolis and caffeic acid phenethyl ester (CAFE) on tyrosine hydroxylase (TH) activity and total RNA levels of Nω-nitro-L-arginine methyl ester (L-NAME) in hypertensive rats caused by nitric oxide synthase inhibition by experimental, insertion and molecular dynamics studies. In conclusion, when looking at the therapeutic effects of bee pollen, propolis and CAPE in hypertension-induced male Sprague-Dawley rats with the L-NAME study, TH activity and catecholamine biosynthesis were increased and total RNA levels have been reported to decrease in the heart, adrenal medulla and hypothalamic tissue of L-NAME-treated rats compared to the control group. Conversely, TH activity and catecholamine biosynthesis were decreased and total RNA levels increased in heart, adrenal medulla and hypothalamic tissue of rats treated with pollen, propolis and CAPE compared to the L-NAME group. In conclusion, it was stated that bee pollen, propolis and CAPE treatment showed antihypertensive and anti-stress effects in general.

No research has been found on the use of bee pollen in the treatment of COVID-19. However, it can be used as an alternative in the treatment process of COVID-19 due to its antiviral effect and disease therapeutic properties in the studies mentioned. However, much more research is needed on this disease treatment process of bee pollen.

4. Bee venom and COVID-19

The therapeutic use of bees and bee products dates back to ancient medical treatments of Egypt, Greece, and China. However, Hungarian Doctor Bodog Beck is reported to have popularized the use of these products in treatment. Bee venom contains more than 40 biologically and pharmacologically active compounds, including phospholipase A2, histamine, epinephrine, free amino acids, peptide melittin and apamin. Melittin, the main component of bee venom, has been reported to have antitumor, antimicrobial, anti-nociceptive and anti-inflammatory activities. It has been reported that bee stings induce the body's immune system in certain places, and can also increase the body's cortisol production [72]. While bee venom has antibacterial, antiparasitidal and antiviral properties [73], phospholipase A2 (PLA2) secreted from bee and snake venom is known to have strong anti-HIV activities. These PLA2s block HIV-1 entry into host cells through a mechanism dependent on PLA2 binding to cells [74]. Melittin, phosphorylase A2 and hyaluronidan, which are the most important components of bee venom, constitute 50% of bee venom. Melittin has been reported to be effective in the treatment of cancer gene and inhibition of HIV-1 virus together with melittin and phosphorylase A2 [75].

[76], investigated the anticancer and antiviral effects of bee venom on cervical cancer cells with differential inhibition of HPV E6 and E7 expression. As a result of the study, it was determined that the suppression of cell growth in cells infected with HPV 16 (CaSki) was higher in the treatment with bee venom than in cells infected with HPV 18. The antitumor effects of bee venom have been shown to be very effective in limiting tumor growth and suppressing tumor growth in vivo, in accordance with *in vitro* data. In addition, mRNA and protein expression levels of HPV16 E6 and E7 have been reported to be reduced by bee venom in TC-1 tumors.

[77], conducted an *in vitro* study on the antiviral effect of bee venom on the foot and mouth disease virus. In the study, the inhibitory effects of bee venom against these viruses were determined using cell-based virus inhibition test, real-time PCR and electron microscopy. It was determined that the levels of interferon-gamma (IFNy) increased in cells treated with bee venom, and they reported that bee venom can be used as a preventive or therapeutic agent.

According to [78] proved that bee venom has antiviral effect in them *in vitro* study on the antiviral effect of the venom of certain honey bees in Egypt and their fraction in influenza virus (pla2). They used bee venom (BV), phospholipase A2 (BV-PLA2) and ribovinal as control drug. The study reported that the cytopathic effect of both BV and ribovinaline was directly proportional to its concentration and incubation time, while BV-PLA2 showed an increase in cytopathic effect after 48 hours despite its concentration in the case of direct antiviral effect. However, the indirect antiviral effect for both BV and PLA2 was noted, showing the same cytopathic effect at all concentrations and incubation times. It was stated that the data of the study revealed the antiviral effect of both BV and BV-PLA2 against influenza virus.

Along with these studies, there are many in-vitro and in-vivo studies on the antiviral and antimicrobial effects of bee venom, and as a result of these studies, it has been determined that bee venom has an antiviral effect [79, 80, 81, 82, 83, 84]. However, research and studies on the use of bee venom, which has antiviral effects, in the treatment of COVID-19 are limited [5, 85, 86, 87, 88, 89]. In their study of the effect on the COVID-19 disease process through prophylactic treatment with azithromycin or bee-derived products, [87] indicated that the use of azithromycin, currently a treatment for COVID-19, as a protector of epithelial barrier function could most likely be realized in a prophylactic rather than a therapeutic context. Similarly, it was stated that since the anti-inflammatory effects of bee products manifest themselves over a period of time, the efficacy of melittin and other bee products can be expected to be maximized in a prophylactic context. In the current pandemic, it has been stated that prophylaxis with azithromycin in bee products, or both, can be used in individuals at high risk for significant COVID-19 infection.

[88], in their research on whether honey bee products containing bee venom can help in the fight against the second wave of COVID-19, stated that bee products containing mixtures of potentially active chemicals have unique properties that can help protect, fight and alleviate the symptoms of COVID-19 infection.

[89], in their statement on the relationship between bee venom and Sars-Cov-2, reported that a total of 5115 beekeepers were surveyed between February 23 and March 8 at the local beekeepers association in Hubei province, the epicenter of COVID-19 in China and 723 of the beekeepers are located in Wuhan. They stated that none of these beekeepers developed symptoms associated with COVID-19 and their health was completely normal. Subsequently, it was reported that five apitherapists were interviewed in Wuhan and 121 patients were observed in the apitherapy clinic. It is stated that these patients and five bee apitherapists who received apitherapy from October 2019 to December 2019 were kept under observation (apitherapy here means using bee venom from a honey bee sting to treat or prevent certain diseases). Without any preventive measures, two out of five apitherapists were confirmed to have been exposed to suspected cases of COVID-19, but ultimately none of them were infected. Of the 121 patients who had close contact with first-degree family members, three of whom were confirmed to be cases of SARS-CoV-2 Infection, none were reported to be infected with SARS-CoV-2. It is assumed that beekeepers are less likely to be exposed to SARS-CoV-2 because they live in less densely populated rural areas. However, considering that the five apitherapists and their patients are located in densely populated areas of Wuhan, what these people have in common is that they can only develop tolerance to bee stings. Therefore, it is stated that this research may reveal that bee venom can be an effective treatment. However, since bee venom was known to cause different reactions in the mentioned study, it was stated that experimental animals, especially monkeys, could be used for a more comprehensive study.

5. Conclusion

At the stage of preparation of this research, it is seen that people resort to alternative prevention and treatment methods in addition to medical methods, at a time when vaccine studies for COVID-19 continue and a definitive treatment method has not yet been developed for the treatment of the disease. One of these methods is the consumption of honey bee (Apis mellifera) products and the increase in demand for these products. The reason for this is that bee products have been used in the treatment of many diseases in alternative medicine from the first ages of history to the present, and in the production of some drugs in pharmacology in recent years, and these products have been the subject of many studies. The aim of the research is to examine the positive effects on COVID-19 and to contribute to the literature for ongoing treatment studies by bringing together the previous studies on royal jelly, bee pollen and bee venom, which have many health benefits with their very rich compositions.

Compliance with ethical standards

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Disclosure of conflict of interest

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version. Additionally, there are no conflicts of interest in connection with this paper, and

the material described is not under publication or consideration for publication elsewhere.

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