Therapeutic Properties of Honey-A Review

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Abstract: Honey is a by-product of flower nectar and the upper aero-digestive tract of the honey bee, which is concentrated through a dehydration process inside the bee hive. Honey has a very complex chemical composition that varies depending on the botanical source. The major components of honey are sugars, which include fructose, glucose, sucrose, maltose and other di- and trisaccharide sugars. Besides sugars, honey contains a wide variety of chemical components such as proteins, fats, vitamins, minerals, enzymes, amino acids, volatile aromatic substances, etc. The diverse nature of these ingredients means that honey is not just a simple sweetener, but a nutritionally worthwhile product. It has been used both as food and medicine since ancient times. In addition to important role of natural honey in the traditional medicine, during the past few decades, it was subjected to laboratory and clinical investigations by several research groups and it has found a place in modern medicine. Honey has been reported to have an inhibitory effect on around 60 species of bacteria, some species of fungi and viruses. Antioxidant capacity of honey is important in many disease conditions and is due to a wide range of compounds including phenolics, peptides, organic acids, enzymes and Maillard reaction products. Honey has also been used in some gastrointestinal, cardiovascular, inflammatory and neoplastic states. This review covers the composition, physicochemical properties and briefly summarizes the best studied features of honey, highlighting it as an appealing alternative medicine.

Key words: Composition * Honey * Physicochemical * Properties * Therapeutics

INTRODUCTION

Honey is the natural sweet substance produced by honeybees from the nectar of blossoms or from the secretion of living parts of plants or excretions of plant sucking insects on the living parts of plants, which honeybees collect, transform and combine with specific substances of their own, store and leave in the honey comb to ripen and mature. Honey is one of those foods that have been around for a lot longer than there were any humans able to harvest or use it. But, since the human species came about, honey began following its development as one of the key foods and overall beneficial nutrients in many different places on the globe. Today, honey is cherished and widely used as much as ever while at one point in the 20th century, the process of refining industrial sugar seemed to be on its way to phasing out honey, in the early 21st century, it is clear that this important product of bees is not going anywhere [1]. One of the reasons for this is the fact that honey is not only nutritious and tastes great, but it also comes with a huge number of medicinal uses. Some of these are cosmetic while others are so important that they could actually protect not just the health of a person, but also their life by stopping some serious illnesses. Here is an overview of the medicinal uses for honey and how it can help so many people with some many different physiological and even psychological conditions. Indeed, medicinal importance of honey has been documented in the world’s oldest medical literatures and since the ancient times, it has been known to possess antimicrobial property as well as wound-healing activity. The healing property of honey is due to the fact that it offers antibacterial activity, maintains a moist wound condition and its high viscosity helps to provide a protective barrier to prevent infection [2].

Its immunomodulatory property is relevant to wound repair too. The antimicrobial activity in most honeys is due to the enzymatic production of hydrogen peroxide. However, another kind of honey, called non-peroxide
honey (Viz., manuka honey), displays significant antibacterial effects even when the hydrogen peroxide activity is blocked. Its mechanism may be related to the low pH level of honey and its high sugar content (High osmolarity) that is enough to hinder the growth of microbes [3]. Antimicrobial agents are essentially important in reducing the global burden of infectious diseases. However, as resistant pathogens develop and spread, the effectiveness of the antibiotics is diminished. This type of bacterial resistance to the antimicrobial agents poses a very serious threat to public health and for all kinds of antibiotics, including the major last-resort drugs, the frequencies of resistance are increasing worldwide. Therefore, alternative antimicrobial strategies are urgently needed and thus this situation has led to a re-evaluation of the therapeutic use of ancient remedies, such as plants and plant-based products, including honey [4]. The belief that honey is a nutrient, a drug and an ointment has been carried in to our days and thus, an alternative medicine branch, called apitherapy, has been developed in recent years, offering treatments based on honey and other bee products against many diseases including bacterial infections. Apitherapists believe that bee products can be used to cure most diseases. However, the use of honey in conventional medicine is limited to certain indications where they have shown effects which are equal to or better than those of standard treatments, for example, in treating wounds and burns and as an interesting approach in arthritis. The objective of this paper is to review the composition, physicochemical and the therapeutic properties of honey [5].

Physical and Chemical Properties of Honey: The physical properties of honey vary, depending on water content, the type of flora used to produce it (Pasturage), temperature and the proportion of the specific sugars it contains. Fresh honey is a supersaturated liquid, containing more sugar than the water can typically dissolve at ambient temperatures. At room temperature, honey is a super cooled liquid, in which the glucose will precipitate into solid granules. This forms a semisolid solution of precipitated glucose crystals in a solution of fructose and other ingredients [6].

Phase Transitions: The melting point of crystallized honey is between 40 and 50°C (104 and 122°F), depending on its composition. Below this temperature, honey can be either in a metastable state, meaning that it will not crystallize until a seed crystal is added, or, more often, it is in a "labile" state, being saturated with enough sugars to crystallize spontaneously. The rate of crystallization is affected by many factors, but the primary factor is the ratio of the main sugars: fructose to glucose. Honeys that are supersaturated with a very high percentage of glucose, such as brassica honey, crystallize almost immediately after harvesting, while honeys with a low percentage of glucose, such as chestnut or tupelo honey, do not be crystallized. Some types of honey may produce very large but few crystals, while others produce many small crystals [7].

Crystallization is also affected by water content, because a high percentage of water inhibits crystallization, as does high dextrin content. Temperature also affects the rate of crystallization, with the fastest growth occurring between 13 and 17°C (55 and 63°F). Crystal nuclei (Seeds) tend to form more readily if the honey is disturbed, by stirring, shaking, or agitating, rather than if left at rest. However, the nucleation of microscopic seed-crystals is greatest between 5 and 8°C (41 and 46°F). Therefore, larger but fewer crystals tend to form at higher temperatures, while smaller but more-numerous crystals usually form at lower temperatures. Below 5°C, the honey will not crystallize, thus the original texture and flavor can be preserved indefinitely [8].

Since honey normally exists below its melting point, it is a super cooled liquid. At very low temperatures, honey does not freeze solid. Instead, as the temperatures become lower, the viscosity of honey increases. Like most viscous liquids, the honey becomes thick and sluggish with decreasing temperature. At -20°C (-4°F), honey may appear or even feel solid, but it continues to flow at very low rates. Honey has a glass transition between -42 and -51°C (-44 and -60°F). Below this temperature, honey enters a glassy state and becomes an amorphous solid (Noncrystalline) [9].

Rheology: The viscosity of honey is affected greatly by both temperature and water content. The higher the water percentage, the more easily honey flows. Above its melting point, however, water has little effect on viscosity. Aside from water content, the composition of honey also has little effect on viscosity, with the exception of a few types. At 25°C (77°F), honey with 14% water content generally has a viscosity around 400 poise, while a honey containing 20% water has a viscosity around 20 poise. Viscosity increase due to cooling occurs very slowly at first. Honey containing 16% water, at 70°C (158°F), has a viscosity around 2 poise, while at 30°C (86°F); the viscosity is around 70 poise. As cooling progresses, honey becomes more viscous at an increasingly rapid
rate, reaching 600 poise around 14°C (57°F). However, while honey is very viscous, it has rather low surface tension, thus the wet ability of honey is on the same order as water, glycerin, or most other liquids. The high viscosity and wet ability of honey lead to the phenomenon of stickiness, which is a time-dependent process in super cooled liquids between the glass-transition temperature (Tg) and the crystalline-melting temperature. Most types of honey are Newtonian liquids, but a few types have non-Newtonian viscous properties. Honey from heather or manuka display thixotropic properties. These types of honey enter a gel-like state when motionless, but then liquefy when stirred. The crystallized honey prepared for this study using edible nuclei retains desirable spreadability in a fine crystal state between 11 and 30°C. As rheological properties are not completely reversible once honey crystals have been thermally damaged, study results advise that, in order to maintain optimal spreadability, crystallized honey should be stored within the 11~30°C temperature range and subjected to minimal temperature variation. In addition, a markedly reduced nuclei dose (0.1% versus the traditional 5~10%) is adequate to facilitate crystallized honey formation. More importantly, it was demonstrated that a small quantity of glucose powder can be used in place of traditional starter seed honey to achieve effective replication [39].

**Electrical and Optical Properties:** Because honey contains electrolytes, in the form of acids and minerals, it exhibits varying degrees of electrical conductivity. Measurements of the electrical conductivity are used to determine the quality of honey in terms of ash content. The effect honey has on light is useful for determining the type and quality. Variations in its water content alter its refractive index. Water content can easily be measured with a refractometer. Typically, the refractive index for honey ranges from 1.504 at 13% water content to 1.474 at 25%. Honey also has an effect on polarized light, in that it rotates the polarization plane. The fructose gives a negative rotation, while the glucose gives a positive one. The overall rotation can be used to measure the ratio of the mixture. Honey may vary in color between pale yellow and dark brown, but other bright colors may occasionally be found, depending on the source of the sugar harvested by the bees [13].

**Hygroscopic and Fermentation:** Honey has the ability to absorb moisture directly from the air, a phenomenon called hygroscope. The amount of water the honey absorbs is dependent on the relative humidity of the air. Because honey contains yeast, this hygroscopic nature requires that honey be stored in sealed containers to prevent fermentation, which usually begins if the honey’s water content raises much above 25%. Honey tends to absorb more water in this manner than the individual sugars allow on their own, which may be due to other ingredients it contains. Fermentation of honey usually occurs after crystallization, because without the glucose, the liquid portion of the honey primarily consists of a concentrated mixture of fructose, acids and water, providing the yeast with enough of an increase in the water percentage for growth. Honey that is to be stored at room temperature for long periods of time is often pasteurized, to kill any yeast, by heating it above 70°C (158°F) [1].

**Thermal Characteristics:** Like all sugar compounds, honey caramelizes if heated sufficiently, becoming darker in color and eventually burns. However, honey contains fructose, which caramelizes at lower temperatures than glucose. The temperature at which caramelization begins varies, depending on the composition, but is typically between 70 and 110°C (158 and 230°F). Honey also contains acids, which act as catalysts for caramelization. The specific types of acids and their amounts play a primary role in determining the exact temperature. Of these acids, the amino acids, which occur in very small amounts, play an important role in the darkening of honey. The amino acids form darkened compounds called melanoidsins, during a Maillard reaction. The Maillard reaction occurs slowly at room temperature, taking from a few to several months to show visible darkening, but speeds up dramatically with increasing temperatures. However, the reaction can also be slowed by storing the honey at colder temperatures [11].

**Acid Content and Flavor Effects:** The average pH of honey is 3.9, but can range from 3.4 to 6.1. Honey contains many kinds of acids, both organic and amino. However, the different types and their amounts vary considerably, depending on the type of honey. These acids may be aromatic or aliphatic (Nonaromatic). The aliphatic acids contribute greatly to the flavor of honey by interacting with the flavors of other ingredients. Organic acids comprise most of the acids in honey, accounting for 0.17-1.17% of the mixture, with gluconic acid formed by the actions of glucose oxidase as the most prevalent. Other organic acids are minor, consisting of formic, acetic, butyric, citric, lactic, malic, pyroglutamic,
propionic, valeric, capronic, palmitic and succinic, among many others [1].

**Volatile Organic Compounds:** Individual honeys from different plant sources contain over 100 volatile organic compounds (VOCs), which play a primary role in determining honey flavors and aromas. VOCs are carbon-based compounds that readily vaporize into the air, providing aroma, including the scents of flowers, essential oils, or ripening fruit. The typical chemical families of VOCs found in honey include hydrocarbons, aldehydes, alcohols, ketones, esters, acids, benzenes, furans, pyrans, nor isoprenoids and terpenes, among many others and their derivatives. The specific VOCs and their amounts vary considerably between different types of honey obtained by bees foraging on different plant sources. By example, when comparing the mixture of VOCs in different honeys in one review, longan honey had a higher level of volatiles (48 VOCs), while sunflower honey had the lowest number of volatiles (8 VOCs) [12].

VOCs are primarily introduced into the honey from the nectar, where they are excreted by the flowers imparting individual scents. The specific types and concentrations of certain VOCs can be used to determine the type of flora used to produce monofloral honeys. The specific geography, soil composition and acidity used to grow the flora also have an effect on honey aroma properties, such as a "Fruity" or "Grassy" aroma from longan honey, or a "Waxy" aroma from sunflower honey [13]. Dominant VOCs in one study were linalool oxide, trans-linalool oxide, 2-phenylacetaldehyde, benzyl ethanol, isophorone and methyl nonanoate [12].

VOCs can also be introduced from the bodies of the bees, be produced by the enzymatic actions of digestion, or from chemical reactions that occur between different substances within the honey during storage and therefore may change, increase, or decrease over long periods of time. VOCs may be produced, altered, or greatly affected by temperature and processing. Some VOCs are heat labile and are destroyed at elevated temperatures, while others can be created during non-enzymatic reactions, such as the Maillard reaction. VOCs are responsible for nearly the entire aroma produced by a honey, which may be described as "Sweet", "Flowery", "Citrus", "Almond" or "Rancid", among other terms. In addition, VOCs play a large role in determining the specific flavor of the honey, both through the aromas and flavor. VOCs from honey in different geographic regions can be used as floral markers of those regions and as markers of the bees that foraged the nectars [1].

**Therapeutic Properties of Honey**

**Anti-bacterial Properties of Honey:** In addition to important role of natural honey in the traditional medicine, during the past few decades, it was subjected to laboratory and clinical investigations. Antibacterial activity of honey is one of the most important findings that were first recognized in 1892 by Van Ketel [14].

**Pathogens Found Sensitive to Honey:** Honey has been reported to have an inhibitory effect to around 60 species of bacteria including aerobes and anaerobes, gram-positives and gram-negatives [15]. Pathogens that are found to be sensitive to anti-infective properties of honey are manifold [16]. Various results are in favor of its activity against *Bacillus anthracis*, *Corynebacterium diphtheriae*, *Haemophilus influenza*, *Klebsiella pneumoniae*, *Listeria monocytogenes*, *Mycobacterium tuberculosis*, *Pasteurella multica*, *Yersinia enterocolitica*, *Proteus species*, *Staphylococcus aureus*, *Streptococcus spp.* and *Vibrio cholera*, *Pseudomonas aeruginosa*, *Acinetobacter spp.*, *Salmonella spp.*, *Serratia marcescens*, *Shigella dysentery* [17].

Unlike most conventional antibiotics, it has been reported that honey dose not lead to development of antibiotic resistant bacteria and it may be used continuously [18]. Honey can act as both bacteriostatic and bactericidal depending on the concentration used. Pasture honey (4-8%) and manuka (5-11%) honey were bacteriostatic whereas bactericidal activity was achieved at 5-10% and 8-15% (v/v) concentrations, respectively. In contrast, artificial honey (sugar solution which mimics composition of honey) was bacteriostatic only (at 20-30%) and not bactericidal [19].

**Possible Mechanisms of Antibacterial Activity of Honey:**

The antibacterial activity (Table-1) is related to four main properties of honey. First, honey draws moisture out of the environment and thus dehydrates bacteria. The sugar content of honey is also high enough to hinder the growth of microbes, but the sugar content alone is not the sole reason for honeys antibacterial properties [20].

Second, the pH of honey is between 3.2 and 4.5 and this acidity is low enough to inhibit the growth of most microorganisms. Hydrogen peroxide produced by the glucose oxidase (*i.e.* the activation of the enzyme glucose oxidase that oxidizes glucose to gluconic acid and H₂O₂) is the third and probably the most important antibacterial component [15]. But, in some cases, the peroxide activity in honey can be destroyed easily by heat or the presence of catalase, several other non-peroxide factors such as
Table 1: Antibacterial factors found in honey and mechanisms [23]

<table>
<thead>
<tr>
<th>S.No</th>
<th>Antibacterial factors</th>
<th>Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Osmotic effect (hygroscopicity, high sugar content).</td>
<td>Based on high osmotic properties it can extract water from bacterial cells and cause them to die.</td>
</tr>
<tr>
<td>2</td>
<td>Acidity (Low PH between 3.2 and 4.5).</td>
<td>The pH being between 3.2 and 4.5 is low enough to be inhibitory to many pathogens.</td>
</tr>
<tr>
<td>3</td>
<td>Hydrogen Peroxide (H₂O₂).</td>
<td>Germicidal due to:- Acidic nature below 4 Ph. :- High concentration nature which exerts high osmotic pressure. :- Dehydrate and inhibit growth of most pathogens, leads to death.</td>
</tr>
<tr>
<td>4</td>
<td>Phytochemical Components (non-peroxide factors i.e. presence of catalase (absence of glucose oxidase)).</td>
<td>Antibacterial factors (methyl syringate And methylglyoxal).</td>
</tr>
<tr>
<td>5</td>
<td>Induction of increased Lymphocyte and phagocytic activity.</td>
<td>Peripheral blood B-Lymphocytes, T-lymphocytes and phagocytes stimulated at concentrations as low as 0.1%. Monocyte (1%) release cytokines, tumor necrosis factor (TNF)-alpha, interleukin (IL)-1 and IL-6, which activate the immune response to infection.</td>
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methyl syringate and methylglyoxal (MGO) have been found to be responsible for the unique antibacterial activity of honey [16].

Inhibition formed in antibiotic susceptibility testing commercial -CFL (Cephalexin-40 mm), OFX (Ofloxacin-15 mm), PEN (Penicillin-10 mm), ENO (Enrofloxacin-10 mm) and AMP (Ampicillin-21 mm), CIP (Ciprofloxacin-20 mm). Inhibition formed in antibiotic susceptibility testing with Tetragonisca angustula honey [21].

**Effect of Honey on Gastritis, Gastroenteritis, Gastric and Duodenal Ulcers:** Gastritis, gastric and duodenal ulcers are complications resulting from infection with *Helicobacter pylori*. Now a days, over half of the human population is colonized by *Helicobacter pylori* (H. pylori), a Gram-negative, microaerophilic bacterium. If untreated, infection is usually life-long and leads to chronic active disease. Although most infected people are asymptomatic, 5-10% of those infected with this bacterium develop severe gastro duodenal diseases, including gastric and duodenal ulcers, gastric lymphomas and gastric adenocarcinomas [22].

Conventional treatment for the eradication of *H. pylori* like triple therapy regimen consisting of a proton pump inhibitor, such as omeprazole and two antibiotics, clarithromycin and either amoxicillin or metronidazole is far from satisfactory, due to the prevalence of antibiotic resistance; thus there is search for alternative treatment. Honey-derived remedies constitute a potential source of new compounds that may be useful in the management of *H. pylori* infections. Clinical and animal studies have shown that honey reduces the secretion of gastric acid. Additionally, gastric ulcers have been successfully treated by the use of honey as a dietary supplement. An 80% recovery rate of 600 gastric ulcer patients treated with oral administration of honey has been reported [24].

**Wound Healing Properties of Honey:** Honey is an effective treatment of wounds because it is non-irritating, non-toxic, self-sterile, bactericidal, nutritive, easily applied and more comfortable than other dressings. Nearly all types of wounds like abrasion, abscess, amputation, bed sores /decubitus ulcers, burns, chill blains, burst abdominal wound, cracked nipples, fistulas, diabetic, malignant, leprous, traumatic, cervical, varicose and sickle cell ulcers, septic wounds, surgical wound or wounds of abdominal wall and perineum are found to be responsive to honey therapy [19].

The treatment of wounds with honey has rendered them bacteriologically sterile within 7-10 days of the start of the treatment and promoted healthy granulation of tissue. Honey was found to be more effective as an antibacterial agent against several *Pseudomonas* and *Staphylococcus* strains than the antibiotic, gentamicin [25].

Conversely, generous soaking of wounds and abscess cavities with honey, sometimes using castor oil to facilitate dressing, was found to include the following advantages: first, cross-infection of wounds often encountered with conventional therapy, was prevented because honey forms a mechanical and/or chemical barrier to infectious agents (Effective in starting the healing process in non-healing ulcers lepers and diabetics) and second, a shorter duration of treatment and therefore hospitalization [26].

In a more recent report on honey treatment of wounds, ulcers and skin graft preservation, the importance of sterile, residue-free honey for medical use was pointed out. It is advisable to use honey derived from specified pathogen- free hives, which have not been treated with drugs and are gathered in areas where no pesticides are used [27].
Effect of Honey on Cardiovascular Diseases: Ischemic heart disease (IHD) causes more deaths and disability and incurs greater economic costs than any other illness in the developed world. Arrhythmias and myocardial infarction (MI) are serious manifestations of IHD. In the course of cardiac surgery and MI, ventricular arrhythmias such as ventricular tachycardia and ventricular fibrillation are the most important causes of mortality [28].

In management of such conditions; drug therapy (Especially anti-arrhythmic drugs) may be lifesaving. On the other hand, the hazards of anti-arrhythmic drugs (Such as lethal arrhythmias in some patients) have led to a limitation on the administration of anti-arrhythmic drugs. Hence, there is a tendency to use drugs which have less adverse effects and more efficacies. Natural honey has been applied for medicinal purposes since ancient times [29]. A wide range of phenolic compounds is present in honey which has promising effect in the treatment of cardiovascular diseases. In coronary heart disease (CHD), the protective effects of phenolic compounds include mainly antithrombotic, anti-ischemic, anti-oxidant (Vitamin C, monophenolics, flavonoids and polyphenolics) and vasorelaxant. It is known that flavonoids decrease the risk of CHD by three major actions: improving coronary vasodilatation, decreasing the ability of platelets in the blood to clot and preventing LDLs from oxidizing [30].

The Antioxidant Property of Honey: Honey is being used since long time both in medical and domestic needs, but only recently its antioxidant property has come to limelight. With increasing demand for antioxidant supply in the food, honey is becoming popular as a source of antioxidant [31]. Oxidative stress results from lack of balancing chemical reaction between the production of free radicals and the natural protective effect of our body resulting into cellular damage and disruption of genetic structure [32].

The molecular mechanisms explaining how normal cells undergo transformation to cancer cells induced by tumor promoters have been the subject of intense investigation. However, studies have revealed the mitogen-activated protein (MAP) kinase signaling pathways are activated differentially by various tumor promoters. Tumor promoters such as UV, 12-O-tetradecanoylphorbol-13-acetate (TPA), Epidermal Growth Factors (EGF), or Arsenic stimulate membrane receptors that activate various Mitogen-Activated Protein (MAP) kinase cascades. MAP kinase cascades regulate transcription factors with a proven role in carcinogenesis. Cellular responses may be survival, development, proliferation, apoptosis and regulation of cell cycle, inflammation and differentiation [33].

Antioxidants bind to the Transcription Factors and prevent harmful effects as cancer, cardiovascular diseases, inflammatory disorders, neurological degeneration, wound healing, infectious diseases and aging. Honey has been found to contain significant antioxidant activity attributed to glucose oxidase, catalase, ascorbic acid, flavonoids, phenolic acids, carotenoid derivatives, organic acids, Maillard reaction products, amino acids, proteins. The main antioxidants in honey are the phenols, such as quercetin, hesperetin and chrysin and the Maillard products called melanoidins [31].

The phenol quercetin directly binds to and strongly inhibits cellular transcription factors’ activities. The inhibition of the transcription factors surpasses the phosphorylation and activation process which avoids cellular effect of the free radicals. It also induces apoptosis (Programmed cell death) of human osteosarcoma cells and reduces protein expression levels in human fibrosarcoma cells [34].

Effect of Honey in Improving the Gut Microbial Balance: Honey is essentially a supersaturated solution of sugars, primarily fructose and glucose and has numerous other minor components. Disaccharides, such as sucrose and maltose and several higher oligosaccharides, containing 3-10 monosaccharide units, constitute between 5 and 10% of honey, depending on the variety. The nutritional composition of honey, which greatly influences its significant physiological effects, is also dependent on various considerations such as pollen sources, processing, storage and environmental conditions [35].

Furthermore, the oligosaccharides are less sweet than the mono and disaccharides, but being mostly non-digestible, are desirable for their potentially prebiotic physiological functions ascribed to the production of metabolites and growth enhancement of probiotics. Appropriate symbiotic combinations, however, can be more effective in benefiting the host than individually administering probiotic or prebiotic. In symbiotic food systems, the probiotic strain is co-administered with specific prebiotic carbohydrates so that a substrate is adequately available for its proliferation [36].

Honey contains potentially prebiotic oligosaccharides and antibacterial components, both of which can synergistically enhance the probiotic efficacy against pathogens. In addition to increasing the viable cell count, other reported benefits include enhanced
probiotic persistence in the GI tract, elevated levels of SCFA and increased resistance to pathogens. Tian et al. [37] provided a good illustration of synergy between probiotics and bovine lactoferrinin enhancing the antibacterial activity against select pathogens. A beneficial synergistic effect of Manuka honey in improving the growth of probiotics and inhibiting the pathogens (Escherichia coli, Salmonella typhimurium and Staphylococcus aureus). In this context, it is interesting to note that strains of Lactobacillus reuteri, which produce the antibacterial reuterin in hosts, have revealed a superior probiotic capability in several studies over the recent decades including against Helicobacter pylori pathogenicity. Besides the aforementioned functionalities, including that against the pathogens, the growth and stability challenges of probiotic species can be addressed to a large extent by prebiotic carbohydrate supplementations [38].

**CONCLUSIONS AND RECOMMENDATIONS**

Today in the demand for beekeeping products in the world in general is growing tremendously high due to the importance of it as inclusion in cosmetic preparation, as natural food, medicinal use and to other values. Different studies shown that, in microbiological and clinical tests, these honeybee products offers many advantages in controlling bacterial growth and in the treatment of certain health problems. Also the administration of honey for the treatment of wounds has desirable features like absence of antibiotic resistance as found with conventional antibiotics, the lack of side effects in alleviating gastric pain and shortening the duration of diarrhea are all. Even in modern day society, the medicinal use of honey still has a place. Therefore, based on the above conclusion the following recommendations are forwarded. Beekeepers should understand the medicinal uses of honeybee products so as to exploit maximum benefit of honey bees. Modern technologies and research results in the subject area should be extended to farmers for better economic benefits. Conventional therapies have many side effects and high costs so, it is necessary to exploit medicinal value of honey which is affordable, accessible nearby and have no side effects.

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