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## Honey and its beneficial therapeutic effects: A review

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### Abstract

Honey is highly nutritious, natural product obtained from honey bees which is wholesome food for old, children and adults. Children, young and old can consume honey, without worrying any side effects. Therapeutic benefits of honey were reported on the basis of various *in vivo* and *in vitro* studies carried out on human and animals. Studies revealed that due to the presence of various phenolic acid and flavonoid compounds in honey, it exhibit antibacterial, antifungal and antiviral activity. In addition to exhibiting antimicrobial activity these phenolic and flavonoid compounds present in honey also act as rich source of antioxidants. Long term consumption of honey can be beneficial against various disorders like diabetes mellitus, cough, wound healing, ophthalmology, cancer, gastro-intestinal and cardiovascular disorders etc. Further research is needed to evaluate the health benefits of honey and its formulations against more diseases.

**Keywords:** Honey, antioxidants, therapeutic effects, diseases

### Introduction

Historical evidences revealed that humans had been using honey bee products like honey from thousands of years in all societies throughout the world (Al-Waili, 2012) <sup>[9]</sup>. Honey is an important natural sweetener that was used relatively early in human history, with the first written evidence found in a Sumerian tablet dating back to 2100–2000 B.C. (Valentini, 2010) <sup>[49]</sup>. Humans actually began hunting for honey around 8,000 years ago, as verified by a cave painting in Valencia, Spain (Crane & Eva 1983) <sup>[15]</sup>. The oldest known honey remains were found in the country of Georgia. Archaeologists found honey remains on the inner surface of clay vessels unearthed in an ancient tomb, dating back some 4,700–5,500 years (Kvavadze, 2006) <sup>[31]</sup>. The spiritual and therapeutic use of honey, in ancient India, is documented in both the Vedas and the Ayurveda texts, which were both composed at least 4,000 years ago (Pecanac, 2013) <sup>[41]</sup>. The properties and physicochemical composition of honey generally varies with the regional and climatic conditions of the place along with the floral sources utilized by the bees for producing honey (Singh & Bath, 1997) <sup>[45]</sup>. Honey is basically concentrated aqueous solution of inverted sugars, along with complex mixture of other saccharides, proteins, amino acids, enzymes, organic acids, polyphenols, and carotenoid-like ingredients, vitamins, minerals and maillard reaction products (MRPs) (Gheldof, 2002) <sup>[21]</sup>. Carbohydrates constitute about 95 to 97% of the dry weight of honey (Alvarez-Saurez, 2009) <sup>[6]</sup>. Glucose and fructose are the most predominant sugars present and are responsible for majority of the physical and nutritional characteristics of honey (Sato & Miyata, 2000) <sup>[43]</sup>. Honey also consists of various phenolic acids and flavonoids which act as an antioxidants to human body by potentially removing free radicals. These antioxidants, particularly flavonoids, exhibit a wide range of biological effects, including antibacterial, anti-allergic, anti-inflammatory, anti-thrombotic, and vasodilatory activities (Cook, 1996) <sup>[14]</sup>. Honey is reported to contain around 181 substances and is deemed as part of traditional medicine. The therapeutic ability of honey is progressively increasing and scientific evidences for the usefulness of honey in numerous experimental and clinical situations are beginning to emerge. Honey has been stated to be beneficial in gastrointestinal (GIT) disorders, wound and burns healing, as an anti-microbial agent and to provide gastric protection against acute and chronic gastric lesions. There are variety of information regarding the health benefits of honey of honey is available for individual diseases like effect of honey on wound healing (Nisbet & Yarim, 2010) <sup>[38]</sup>, honey for treating cardiovascular diseases (Farooqui, 2011) <sup>[20]</sup>; stimulatory effect of honey on multiplication of lactic acid bacteria (Shamala, 2000) <sup>[44]</sup>; antimicrobial activity of honey (Gulfraz, 2010) <sup>[22]</sup>; antiproliferative effects (Jaganathan & Mandal, 2009) <sup>[24]</sup>; bactericidal activity (Mullai & Menon, 2007) <sup>[38]</sup>; plasma prostaglandin lowering effect (Al-Waili & Boni, 2003) <sup>[7]</sup> is available.

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However only a few information on combined data regarding composition and therapeutic health benefits of honey against various diseases is available. The objective of this review paper is to summarize the therapeutic effects of honey against various ailments.

### Therapeutic Health Effects

Honey is primarily made of water and carbohydrates. In addition to these, honey also comprises several minerals and vitamins. Other constituents like niacin, calcium, copper, riboflavin, iron, magnesium, potassium and zinc are also present in honey. Honey also consists flavonoids and phenolic

acids. These flavonoids and phenolic acids act as an antioxidants which eliminates the potentially destructive free radicals in the human body. Honey has been used for its medicinal properties to treat a wide variety of ailments. It may be used alone or in conjunction with other substances and administered orally or topically for the eradication of certain diseases. However, misuse of antibiotics, the emergence of resistant bacteria, high cost and unavailability of some conventional drugs and increasing interest in therapeutic honey have provided an opportunity for honey to be used as a broad-spectrum antibacterial agent (Manyi-Loh, 2011) [33].

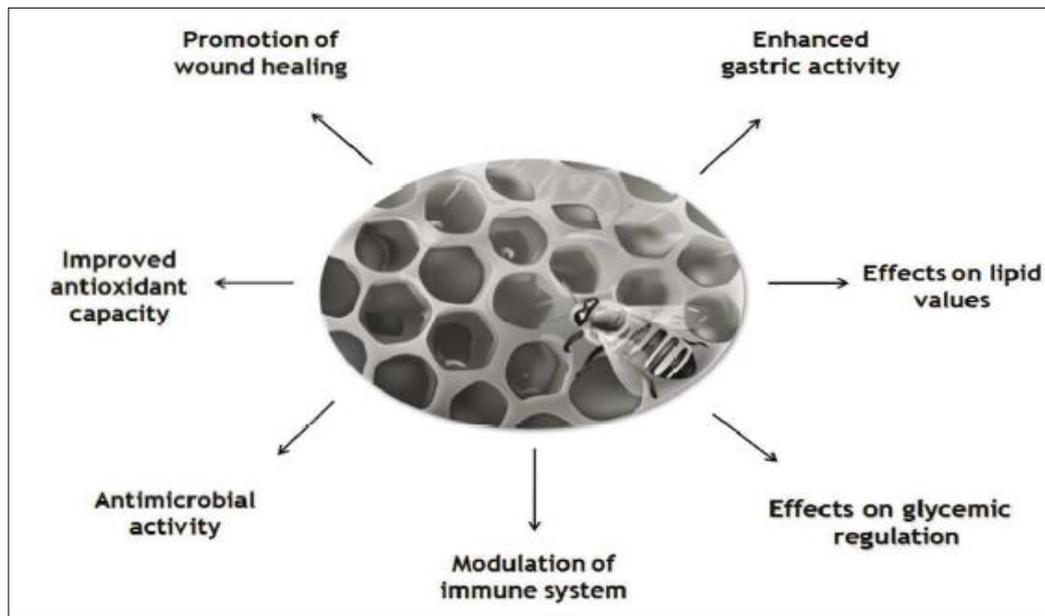


Fig 1: Health benefits of honey (Farooqui, 2011) [20].

### Diabetes mellitus

Honey has been used in the medications for diabetes since ancient times. In several regions, patients suffering from diabetes mellitus use honey in place of sugar. This could be due to the reason that honey is beneficial for diabetic patients in two ways. In one way, it is being three times sweeter than sugar, hence required in much smaller quantity as a sweetener in comparison to sugar. Moreover, honey contains lesser calories than sugar on weight (w/w) basis. The second reason is, by providing vitamins C, B<sub>2</sub>, B<sub>4</sub>, B<sub>5</sub>, B<sub>6</sub>, B<sub>11</sub> and minerals like calcium, magnesium, iron, potassium, zinc, phosphorous, manganese, chromium and selenium (Ediriweera & Premarathna, 2012) [17]. In earlier observations, it was found that honey stimulates insulin secretion, decrease blood glucose levels, elevates haemoglobin concentration and improves lipid profile (Al-Waili & Haq, 2004) [8]. Moreover, (Katsilambros, 1988) [29] also indicated that honey could be an appropriate sweetener for the type II diabetic patients.

### Cough

Cough is a major concern for all people and is one of the most frequent complaints presented to almost all general physicians (Chang and Widdicombe, 2007) [13]. The adverse effects of cough are even more harmful among children in comparison to adults. Immune system of children is immature, as a consequence of which they have more susceptibility to several infections associated with chronic coughing (Ahmad, 2016) [1]. Paul (2007) [39] reported clinical symptoms improvements between the various treatment groups with honey dosage and found that honey acts an excellent medicine in the treatment

of coughing. Meo, (2017) [34] reported that honey is better for the symptomatic relief of night time cough and sleep difficulty allied with childhood upper respiratory infections.

### Ophthalmology

Honey is used worldwide for the treatment of various ophthalmological conditions like blepharitis, conjunctivitis, keratitis, corneal injuries, chemical and thermal burns to eyes. In one study, with topical application of honey as ointment, in 102 patients with non-responsive eye disorders, improvement was seen in 85% patients. Application of honey in infective conjunctivitis reduced swelling, redness, pus discharge and time to bacterial eradication. (Eteraf-Oskouei, & Najafi, 2013) [18].

### Antimicrobial activity

Gulfraz, (2010) [22] studied the antimicrobial activity of honey and reported that when different honey formulations are used in comparison to control, it significantly inhibited the growth of various micro-organisms like *Escherichia coli*, *Staphylococcus aureus*, *Aspergillus niger* and *Candida albicans*. The antimicrobial activity of honey is attributed due to flavonoids and phenolic acids present in honey. The most important flavonoid being pinocembrin, pinobanksin and chrysin which are present in honey. Hydrogen peroxide is not the only inhibine present in honey, but it is one of a whole group of antimicrobial substances or inhibines (Wahdan, 1998) [50].

Ceyhan & Ugur, (2001) [12] while studying the antimicrobial activity of 84 honey samples against 8 bacteria and 2 fungal

strains concluded that honey samples with thyme, thyme + pine + chestnut acorn, pine + carob and pine + carob + anis are more effective than the other honey of floral sources. The results revealed that most of honey samples at 50% (w/v) can completely inhibit the growth of all of the tested bacteria. However, the fungi were less sensitive than the bacteria to the antimicrobial activity of honey.

### Fungal infections

Honey has been reported to have inhibitory effects on fungi. Pure honey inhibits fungal growth and diluted honey appears capable of inhibiting toxin production (Al-Waili & Haq, 2004) <sup>[8]</sup>. An antifungal action has also been observed for some yeast and species of *Aspergillus* and *Penicillium*, as well as all the common *dermatophytes* (Kumar, 2010) <sup>[30]</sup>. Candidiasis, caused by *Candida albicans*, may respond to honey (Bansal, 2005) <sup>[12]</sup>. Cutaneous and superficial mycoses like ringworm and athlete's foot are found to be responsive to honey. This responsiveness is partly due to the inhibition of fungal growth and partly to inhibition of bacterial infection. In addition, some studies have reported that topical application of honey was effective in treating seborrheic dermatitis and dandruff.

### Antiviral effects of honey

In addition to antibacterial and antifungal effects, natural honey has showed antiviral effect. Al-Waili (2004) <sup>[8]</sup> investigated the effect of the topical application of honey on recurrent attacks of herpes lesions and concluded that topical honey application was safe and effective in the management of the signs and symptoms of recurrent lesions from labial and genital herpes compared to acyclovir cream. Honey has also been reported to have inhibitory effects on rubella virus activity (Eteraf-Oskouei, & Najafi, 2013) <sup>[18]</sup>.

### Wound healing & honey dressings

Nisbet, (2010) <sup>[38]</sup> evaluated the effects of blossom, chest-nut and rhododendron honey types on the healing of full-

thickness wounds in 24 white female rabbit models. It was observed that healing of wounds in the honey-treated groups was much faster than the control group. Honey accelerates the inflammatory reaction and initiates healing early in the treatment process. Honey when used as a dressing generally causes no pain, non-irritating and non-allergic to wounds. Over all the reports of honey being used on wounds, with a total of more than 600 cases, there have been no reports of any harmful effects of honey on tissues. Honey dressings are easy to apply and remove because there is no adhesion to cause damage to the exposed re-growing tissues on the surface of wounds. Also there is no bleeding while removing dressings. Any honey left on the surface of the wound is easily removed by simple bathing, unlike with many other dressing materials which have to be wiped off or forcefully washed off (Molan, 2015) <sup>[37]</sup>.

### Cardioprotective effects

Yaghoobi, (2008) <sup>[53]</sup> investigated the study on 55 patients, who were overweight or obese, in the control and experimental groups, body weight, body mass index, body fat weight, total cholesterol, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triacylglycerole, fasting blood glucose (FBG) triacylglycerole and C-reactive protein (CRP), were measured before treatment and at day 31 after the beginning of treatment and found that honey caused a mild reduction in body weight (1.3%) and body fat (1.1%). Honey reduced total cholesterol (3%), LDL-C (5.8), triacylglycerole (11%), FBG (4.2%), and CRP (3.2%), and increased HDL-C (3.3%) in subjects with normal values, while in patients with elevated variables, honey caused reduction in total cholesterol by 3.3%, LDL-C by 4.3%, triacylglycerole by 19%, and CRP by 3.3%. Consumption of natural honey reduces cardiovascular risk factors, particularly in subjects with elevated risk factors, and it does not increase body weight in overweight or obese subjects.

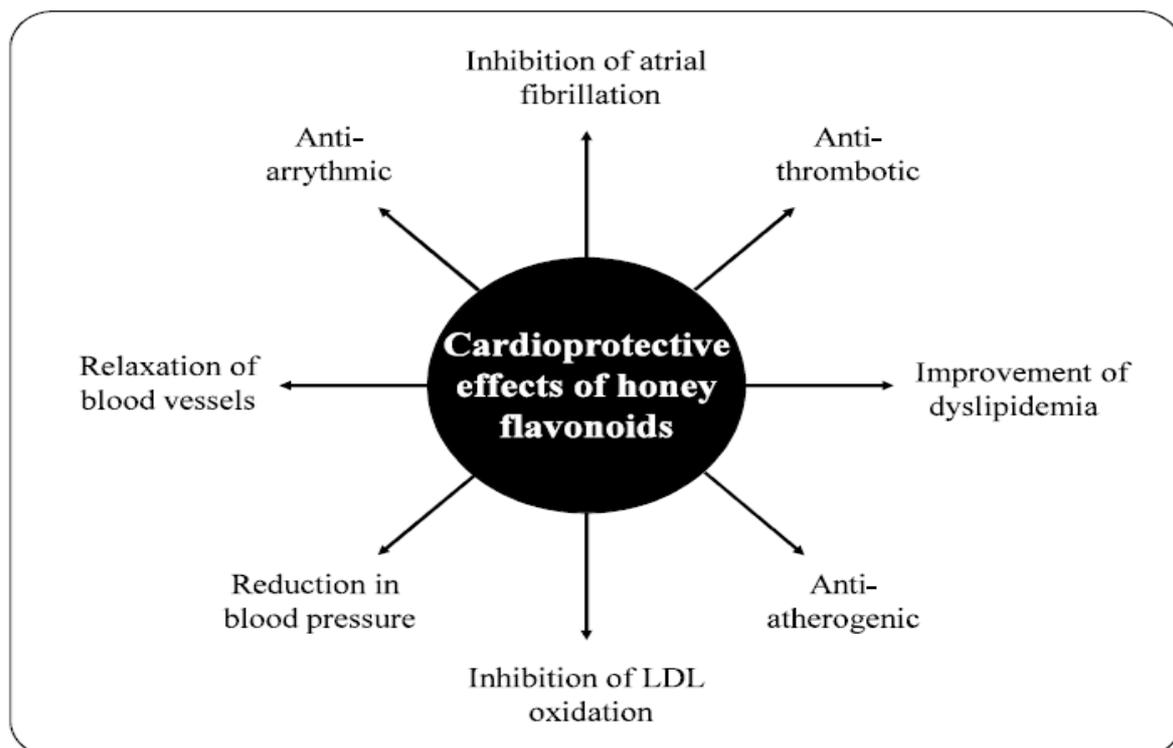


Fig 2: Cardio protective effects of honey

### Gastro intestinal disorders

Earlier studies advocate the medicinal use of natural honey as therapeutic agent against the various gastro-intestinal tract (GIT) disorders. Honey has been used for the prevention, cure and the treatments of some GIT disorders such as ulcers, gastritis and gastroenteritis. Honey has been shown to be a gastro-protective agent. Its potency in inhibiting the activity of *Helicobacter pylori*, that causes gastritis and peptic ulcers have been well documented (Ajibola, 2012) [2]. Infections of the intestinal tract are common throughout the world, affecting people of all ages. The infectious diarrhoea exacerbates nutritional deficiencies in various ways, but as in any infection, the calorific demand is increased. Pure honey has bactericidal activity against many enteropathogenic organisms, including those of the *Salmonella* and *Shigella* species, and enteropathogenic *E. coli* (Jeddar, 1985) [25]. *In vitro* studies of *Helicobacter pylori* isolates which cause gastritis have been shown to be inhibited by a 20% solution of honey. Even isolates that exhibited a resistance to other antimicrobial agents were susceptible (Ali, 1991) [3]. In a clinical study, the administration of bland diet and 30 mL of honey three times a day was found to be an effective remedy in 66% of patients and offered relief to a further 17%, while anaemia was corrected in more than 50% of the patients (Salem, 1981). A clinical study of honey treatment in infantile gastroenteritis was reported by Haffjee & Moosa (1985) [23]. Honey was found to shorten the duration of diarrhoea in patients with bacterial gastroenteritis caused by organisms such as *Salmonella*, *Shigella* and *E. coli*. 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 (Kandil, 1987) [27]. An 80% recovery rate of 600 gastric ulcer patients treated with oral administration of honey has been reported (Kandil, 1987) [27]. Radiological examination showed that ulcers disappeared in 59% of patients receiving honey.

### Cancer

Honey contains an array of chemicals endowed with antiradical/anti-inflammatory activity, i.e., phenolic derivatives, which can play an important role, alone or in combination, in their antitumour, anti-inflammatory effects (Facino, 2001) [19]. The antitumoural effects of honey seem to be due to a multifactorial process, such as: (1) release of cytotoxic H<sub>2</sub>O<sub>2</sub> (and of HO radicals after Fenton reaction) (2) a direct inhibition of COX-2 by some specific constituent (chrysin and caffeic acid phenyl ethyl ester, CAPE) and (3) scavenging action against different reactive oxygen species (ROS) responsible for induction of the inflammatory burst, which if not properly quenched/contained can degenerate into cell malignancy (Alvarez-Suarez, 2010) [6].

The antimutagenic activity of honeys from seven different floral sources (acacia, buckwheat, fireweed, soybean, tupelo and Christmas berry) against Trp-p-1 was tested by the Ames assay and compared to a sugar analogue as well as to individually tested simple sugars (Wang, 2002) [51]. All honeys exhibited a significant inhibition of Trp-p-1 mutagenicity. The anti-metastatic effect of honey and its possible mode of anti-tumour action was studied by the application of honey in spontaneous mammary carcinoma in methylcholanthrene-induced fibrosarcoma of CBA mice and in anaplastic colon adenocarcinoma of Y59 rats (Orsolic & Basic, 2004) [39]. In another study the anti-tumour effect of honey against bladder cancer was examined *in vitro* and *in vivo* in mice by Swellam, (2003) [46] and concluded that honey

is an effective agent for inhibiting the growth of different bladder cancer cell lines (T24, RT4,253J and MBT-2) *in vitro*. It is also effective when administered intra-lesionally or orally in the MBT-2 bladder cancer implantation mice models.

### Boosting of the immune system

Due to its antibacterial activity, honey plays an important role against infection through stimulating the body's immune system to fight infections. This may be due to the reason that honey stimulates the T-lymphocytes and B-lymphocytes in cell culture to multiply, and activate neutrophils (Tonks, 2003) [47]. Moreover; Jones, (2000) in their study reported that the release of the cytokines IL-1, IL-6 and TNF-alpha the cell "messengers" due to stimulation of monocytes in cell cultures which further activate many facets of the immune response to infection. Recently, Tonks, (2007) [48] discovered a 5.8 kDA component of manuka honey which stimulates the production of TNF- in macrophages via Toll-like receptor. In addition, honey provides a supply of glucose, which is essential for the "respiratory burst" in macrophages that produce hydrogen peroxide, the dominant component of their bacteria-destroying activity (Molan, 2001) [35]. Moreover, it provides substrates for glycolysis, the major mechanism for energy production in the macrophages, and thus allows them to function in damaged tissue and exudates where the oxygen supply is often poor. The acidity of honey may also assist in the bacteria-destroying action of macrophages, as an acid pH inside the phagocytic vacuole is involved in killing ingested bacteria (Molan, 2001) [35].

### Source of antioxidants

Oxidative stress, caused by an imbalance between the production of highly reactive molecules and antioxidant defences, causes structural and functional damage to proteins, lipid and nucleic acids leading to many biological complications including aging, carcinogenesis, and atherosclerosis (Droge, 2002) [16]. Earlier studies also revealed that a diet rich in polyphenols is often associated with a lower risk of many chronic diseases like obesity, infections, cancer cardiovascular and neurologic diseases etc. Therefore, antioxidants taken from diet can balance the harmful effects of free radicals hence protect from oxidative damage (Bach-Faig, 2011) [10]. Honey has been found to have a significant source of antioxidants which have the capacity to scavenge free radicals. Flavonoids and other polyphenols, present in the honey impart antioxidant activity to honey (Molan, 2001) [35]. Phenolic acids present in honey are Gallic acid, 4-dimethylaminobenzoic acid, *p*-coumaric acid, caffeic acid, vallinic acid, chlorogenic acid and syringic acid.

### Conclusion

These days' researchers are paying more attention to medicines which are of natural origin and believe that these natural products may be act as an effective therapeutics in comparison to the synthetic drugs. The aim of this review paper is to summarize the therapeutic effects of honey against various ailments. Honey is one of the important product among those, which has been used for various medicinal applications since ancient times. In addition to its important role in the traditional medicine, researchers also accept honey as a new alternative medicine for curing number of ailments. There are number of therapeutic effects of honey which play important role in the treatment of cough, diabetes, boosts immune system, gastro-intestinal disorders, cardiovascular diseases, cancer, wound healing, ophthalmology, fungal,

bacterial and viral infections. On the basis of various health effects of honey, it is highly recommended to incorporate honey or other honey products in daily diet for the prevention of various diseases.

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