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## Honey and its health benefits in our day-to-day life

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**Abstract**

Since ancient times, honey has been valued for its healing properties as a natural ingredient. Due to the strong antioxidant and anti-inflammatory effects that flavonoids and phenolic acids have, they have a significant impact on human health. Honey has antibacterial properties and anticancer effects against several tumor types by influencing various biochemical pathways involved in cellular proliferation. The decrease in the serum concentrations of glucose, fructosamine, and glycosylated haemoglobin has also been noted as a further antidiabetic activity. Additionally, honey has a protective impact on the brain system, the respiratory system against bacterial infections and asthma, the cardiovascular system, where it primarily inhibits the oxidation of low-density lipoproteins, and the gastrointestinal system. In athletes, honey has been shown to have positive effects. The goal of this review is to compile and update the most recent data on the effects of honey on health and disease.

**Keywords:** Antimicrobial activities, antioxidants, cancer, diabetes, disease prevention, honey, polyphenols

**Introduction**

One of the miracles of nature is honey. Although honey has been around for a while, we don't know much about it [8]. Honey is a natural product made by *Apis mellifera* honey bees [5]. Honey bees gather nectar, flower or other plant secretions, and the waste products of insects that feed on plants. Then, honey bees change these molecules by fusing them with certain substances of their own. These are put into the honey comb, dehydrated, and allowed to ripen and mature there [4]. The hives can subsequently be used to extract honey for human use. Evidence from antiquity suggests that people have been gathering wild honey for 10,000 years. But by 2400 BC, the practice of beekeeping had at least become well-established in Egypt, where honey was utilized as a natural food source [12]. Currently, less than 1% of the world's total sugar production-or around 1.2 million tons annually is produced by honey [5]. The only naturally occurring product made from insects is honey, which has benefits for industry, cosmetics, medicine, and nutrition [1].

Honey was ingested by the majority of ancient populations, including the Greeks, Chinese, Egyptians, Romans, Mayans, and Babylonians, for both nutritional and therapeutic reasons [1]. In actuality, humankind's interaction with bees' dates back to the Stone Age. On a Sumerian tablet from between 2100 and 2000 BC, the first written reference to honey cites its usage as an ointment and a drug [5].

Honey has been shown to have bactericidal effects on a wide range of species, including *Salmonella*, *Shigella*, *Escherichia coli*, and *Helicobacter pylori*. Additionally, studies have suggested that honey may have anti-inflammatory properties and trigger the immune system to respond to a wound. It's interesting to note that honey has been proven in several *in vitro* experiments to inhibit the oxidation of low density lipoprotein (LDL) caused by reactive oxygen species (ROS), providing advantageous cardiovascular protection. It has long been known that using honey to treat hepatic, cardiovascular, gastrointestinal, and other conditions is effective [3].

Several natural merchandise that are used as drugs are replaced by fashionable prescription drugs, however recently they need came back to the planet stage thanks to the growing public interest [11]. Nowadays, info on the usage of honey for the cure of the many human diseases may be found generally magazines, journals, and natural products' leaflets and suggesting a large form of unknown [1].

An alternate drugs branch, known as apitherapy, has developed in recent years, providing treatments supported honey and different bee merchandise for several diseases [5]. Honey is made in giant quantities worldwide. National Honey Month may be a social occasion and promotional event control annually throughout the month of September within the US. The aim of this event is to market yank apiculture trade and honey as a natural and helpful sweetener. In step with Food and Agriculture Organization, among the honey manufacturing countries, Russia is within the high and followed by Asian country, Mexico, Iran, Romania, Republic of peninsula, New Zealand, Poland, and Kenya [12]

### Types of honey

About 320 different types of honey are available, coming from various floral sources. A particular type of honey's flavor, color, and aroma will rely on the numerous liquid sources found in the flowers and plants that the honey bee visits. In terms of temperature, rainfall, and seasonal and climatic fluctuations, various types of honey are comparable. The color of honey varies based on where the honey bees swarmed, from light brown to dark brown [10].

### Components of honey

Honey's major component, accounting for 95-97% of its dry weight, are carbohydrates [1]. Carbohydrates may be an extremely complicated mixture of sugars, most of that are within the forthwith predigested kind within the bowel [5]. Monosaccharides (fructose and glucose) are the foremost vital sugars of honey and will be contributed to the foremost of the organic process and physical effects of honey [28]. Additionally to monosaccharides, smaller quantities of disaccharides (sucrose, galactose, alpha, beta-trehalose, gentiobiose, and laminaribiose), trisaccharides (melezitose, maltotriose, 1-ketose, panose, isomaltosealdohexose, erlose, isomaltotriose, theanderose, centose, isopanose, and maltopentaose), and oligosaccharides are gift in honey [1].

In this method of digestion once honey intake the principal carbohydrates, ketohexose and aldohexose, are quickly transported into the blood and may be used for energy needs by the physique. A daily dose of twenty grams of honey can cowl regarding three-d of the desired daily energy [5].

Gluconic acid, a product of aldohexose reaction, is that the main organic acid that's gift in honey; additionally, little amounts of carboxylic acid, formic, and acid are found [1].

Honey conjointly consists of some vital amino acids, like all 9 essential amino acids and every one nonessential amino acids apart from amino acid and aminoalkanoic acid. Amino acid was reported because the primary aminoalkanoic acid in honey, followed by different sorts of amino acids [1].

Enzymes (diastase, invertases, aldohexoseenzyme, catalase, and acid phosphatase) represent the most macromolecule ingredients of honey [1]. Accelerator aldohexose enzyme produces element peroxide (which provides antimicrobial properties) on withgluconic acid from aldohexose that helps in metallic element absorption. Disaccharidase converts disaccharide to ketohexose and aldohexose. Dextrin and malt sugar ar made from long starch chains by the activity of enzyme accelerator [3]. Enzyme helps in manufacturing chemical element and water from element peroxide [3]

31 variable minerals are found in honey, together with all of the foremost minerals, like phosphorus, sodium, calcium, potassium, sulfur, magnesium, and gas [1].

Many essential trace parts are detected in honey, like element (Si), Rb (RB), metallic element (V), metallic element (Zr), metal (Li), and metallic element (Sr). However, some significant metals like lead (Pb), metal (Cd), and arsenic (As) are found as pollutants [1].

The volatile compounds of honey are usually low however embodies contain aldehydes, alcohols, hydrocarbons, ketones, acid esters, benzene and its derivatives, pyran, hydrocarbon and its derivatives, norisoprenoids, sulfur, furan, and cyclic compounds [1].

Galangin, quercetin, kaempferol, luteolin, and isorhamnetin are some examples of bioactive chemicals that are present in all types of honey, although naringenin and hesperetin are only present in certain varieties [1].

Acid, syringic, ellagic, carboxylic, cinnamic, chlorogenic, caffeic, isorhamnetin, ferulic acids, myricetin, chrysin, coumaric acid, apigenin, quercetin, kaempferol, hesperetin, galangin, catechin, luteolin, and naringenin are among the phenolic and flavonoid [1].

Nitrogenous compounds, vitamins C, B1 (thiamine) and B2 complicated vitamins like hepatoflavin, niacin, B6 and panthothenic acid are found [3].

### Major components of honey

- Carbohydrates
- Organic acid
- Amino acids
- Enzymes
- Minerals
- Essential compounds
- Volatile compounds
- Bioactive compounds
- Phenolic compounds
- Flavonoid compounds
- Nitrogenous compounds

### Chemical composition of natural honey

Natural honey largely consists of sugar and water, but it also contains over 200 different components, such as vitamins, minerals, enzymes, and amino acids. 95-99% of the dry matter in honey is made up of sugar. Fructose (32.66-28.2%) and glucose (28.54-31.3%), which make up 85-95% of the total sugars that are easily absorbed in the gastrointestinal tract, are the main carbohydrate components of honey [24, 15].

Disaccharides such as maltose, sucrose, isomaltose, turanose, nigerose, meli-biose, panose, maltotriose, and melezitose are examples of other sugars. There are also a few oligosaccharides present. Four to five percent of honey contains fructo-oligosaccharides, which act as probiotics.

The second most crucial ingredient in honey is water. Gluconic acid, a by-product of the enzymatic breakdown of glucose, is one of the organic acids that make up 0.57% of honey. Honey's acidity and a major portion of its distinctive flavour are both caused by the organic acids. Mineral compounds can be found in concentrations of 0.1% to 1.0%. The main metal is potassium, followed by the elements calcium, magnesium, sodium, sulphur, and phosphorus. Among the trace elements are manganese, copper, zinc, iron, and copper [17-19].

Additionally, nitrogenous substances, vitamins C, B1 (thiamine), and B2 (riboflavin, nicotinic acid, B6, and panthothenic acid), are present. Only trace amounts of proteins (0.1-0.5%) are found in honey. A recent study

found that certain protein amounts vary depending on the type of honeybee that produced them <sup>[20-23]</sup>.

### Physical properties of natural honey

Along with its composition and flavor, honey has a number of significant characteristics. Honey that has just been extracted is a thick liquid. Its viscosity is dependent on a wide range of elements and hence changes depending on its composition, especially its water content. Another characteristic of honey is hygroscopicity, which refers to the substance's capacity to take in and retain moisture from its surroundings. When the relative humidity of the air is above 60%, normal honey with a water content of 18.8% or less will absorb moisture. Honey's surface tension varies depending on where it comes from and is likely caused by colloidal materials. It contributes to the foaming properties of honey along with high viscosity <sup>[18]</sup>.

Liquid honey can be transparent and colorless (like water) or it can be dark amber or even black. The numerous hues of honey are essentially all variations of amber and yellow. The amount of suspended particles, such as pollen, determines transparency or clarity, whereas color varies with botanical origin, age, and storage circumstances. Bright yellow (sunflower), chestnut with red overtones, greyish (eucalyptus), and greenish are less common honey colors (honeydew). Honey loses some of its color when it crystallizes because glucose crystals are white. The production of monohydrate glucose crystals, which vary in quantity, shape, dimension, and quality depending on the content of the honey and the storage circumstances, causes honey to crystallize. The rate of crystallization increases with honey's water content and decreases with glucose content <sup>[19]</sup>.

### Traditional history of natural honey

According to drawings from the Stone Age, humans have been using honey for approximately 8000 years. Honey was used by the ancient Egyptians, Assyrians, Chinese, Greeks, and Romans to treat wounds and digestive problems. Here is a summary of some of the health benefits of honey that have been used by prehistoric peoples <sup>[16-20]</sup>.

### Honey in Indian system of ayurveda

Ayurveda is a composite word made up of the words âyus, which means "life" or "life principle," and veda, which means "a system of knowledge." As a result, the name "Ayurveda" loosely translates to "knowledge of life". Honey was regarded by the ancient Vedic civilisation as one of nature's most amazing gifts to humans. According to ancient Ayurvedic writings, honey traditionally helps people with poor digestion. Additionally, it has been underlined how effective honey is in treating annoying coughs. Ayurvedic specialists consider honey to be beneficial for maintaining healthy teeth and gums. It has a hypnotic effect, which has been used for millennia to cure insomnia. Ayurvedic practitioners from the past also suggest honey for anaemia, all lung imbalances, wounds and burns, cardiac pain, and burns and wound healing. Ayurvedic practitioners have historically used honey to treat numerous eye conditions. It boosts vision when applied daily to the eyes. Honey is also thought to be helpful in preventing cataracts <sup>[16-20]</sup>.

### Honey in ancient Egypt

Honey changed into the maximum famous Egyptian drug being noted 500 instances in 900 remedies. The Smith

papyrus, an Egyptian book written between 2600 and 2200 B.C., contains a prescription for a modern wound salve that calls for a combination of mrht (grease), byt (honey), and fit (lint/fibre), transliterated from hieroglyphic characters. Almost all Egyptian drugs contained honey collectively with wine and milk. The ancient Egyptians presented honey to their deities as a sacrifice. They additionally used honey for embalming the dead. Honey changed into applied for its antibacterial homes that helped heal inflamed wounds <sup>[16-20]</sup>.

### Honey in ancient greece

Oenomele is an historical Greek beverage consisting of honey and unfermented grape juice. It is now and again used as a peoples' treatment for gout and positive worried disorders. Hippocrates, the wonderful Greek scientist, prescribed an easy diet, favouring honey given as oxymel (vinegar and honey) for pain, hydromel (water and honey) for thirst, and an aggregate of honey, water and diverse medicinal materials for acute fevers. Also he applied honey for baldness, contraception, wound healing, laxative action, cough and sore throat, eye diseases, topical antiseptics, prevention and remedy of scars <sup>[16-20]</sup>.

### Honey in Islamic medicine

In Islamic scientific system, honey is taken into consideration a healthful drink. The holy Qur'an vividly illustrates the ability therapeutic price of honey: "And thy Lord taught the bee to construct its cells in hills, on trees, and in (men's) habitations; Then to devour of all of the produce (of the earth), and locate with ability the spacious paths of its Lord: there troubles from inside our bodies a drink of various colors, in which is recuperation for men: verily in that is a signal for individuals who provide thought". Moreover, the Muslim prophet Mohammad (SAW) encouraged the usage of honey for the remedy of diarrhea. Avicenna, the terrific Iranian scientist and physician, nearly 1000 years ago, had encouraged honey as certainly considered one among high-quality treatments within side the remedy of tuberculosis <sup>[16-20]</sup>.

### Biological Activites

#### Antioxidant activity

Honey's ability and potential to lessen oxidative reactions in food systems and human health is referred to as antioxidant activity or simply antioxidant capacity. In particular, these oxidative processes have the potential to harm food products <sup>[5]</sup>. An antioxidant is a substance that prevents other molecules from oxidising. A biological process called oxidation produces free radicals, which can damage cells, tissues, and eventually bodily functions <sup>[10]</sup>. Given that oxidative stress is a known cause of numerous diseases, researchers from a wide range of fields have been more interested in natural sources that might include substances that could help prevent or lessen the effects of oxidative stress on cells <sup>[3]</sup>.

Studies showed that natural honey has a role to play in slowing down the ageing process and reducing the production of highly reactive ingredients like free radicals and reactive oxygen species (ROS), which are produced during metabolism. These substances interact with DNA, enzymes, and the lipids and proteins that make up cell membranes. These harmful interactions could result in a number of disorders <sup>[1]</sup>.

Honey's ability as an antioxidant is influenced by the antioxidants that naturally exist in honey <sup>[5]</sup>. As an

antioxidant, honey offers a wide range of preventive capabilities against a wide range of clinical problems, including cancer, coronary artery disease, neurological deterioration, and inflammatory disorders [10].

### Antibacterial activity

The creation of antibiotics, which are either bacteriostatic or bactericidal and may either kill microorganisms directly or stop their growth, is one of the advancements of modern medicine. However, a key problem is that microorganisms are becoming more and more resistant to these antibiotics. In addition to using antibiotics, basic hygiene practises and vaccinations can be used to avoid bacterial illnesses [11].

Acinetobacter spp., Haemophilus influenzae, Klebsiellapneumoniae, Mycobacterium tuberculosis, Pasteurellamultocida, Yersinia enterocolitica, Proteus species, Pseudomonas aeruginosa, Salmonellatyphi, Serratiamarcescens, Shigella dysentery, Bacillus anthracis, Staphylococcus aureus, Streptococcus mutans, Strep. Pneumoniae, Streptococcus pyogenes, and Vibrio cholerae are some of the bacteria that have been documented to be susceptible to honey's antibacterial properties [12]

The enzyme glucose oxidase from bees played a major role in the anti-bacterial effect by producing hydrogen peroxide. The overall and non-peroxide actions of honey have an antibacterial effect. According to available data, honey is necessary for both Gram-positive and Gram-negative germs to be effectively combated [10].

Honey had strong antibacterial activity against all of the bacteria that were investigated, which are connected to urinary tract infection, skin lesion, and enteric fever in human patients, respectively. As a result, honey can be thought of as an alternative treatment for such infections. When honey is used as an oral rehydration fluid, it can lessen the symptoms of one of the most prevalent bacterial contamination symptoms in addition to being helpful against bacterial infections the length of the bacterial diarrhea [11]

The honey generated by Africanized Honey Bees from primarily Mimosa and Eucalyptus showed the highest antibacterial activity when classified according to the major floral source. The strongest antibacterial effects were seen in Meliponasubnitida honey made from Mimosa bimucronata and Plebia species honey made from Borreria/Mimosa [7].

### Antiviral activity

Because viruses typically stay contagious in dry mucus for a long period, they are the most common and challenging to cure of all infectious disorders that affect humans. Additionally, viruses require host cells in order to replicate, therefore eliminating the virus also implies eliminating the host cell. Consequently, the best strategy to avoid these diseases is by immunization [11].

Numerous research indicate that various types of honey have potent antiviral properties. Zeina made the suggestion that honey can effectively combat the rubella virus in 1996 [4]. The care of the signs and symptoms of recurring lesions from labial and genital herpes was found to be safe and successful with topical honey application [3].

According to studies, honey has antiviral properties against the influenza virus, the respiratory syncytial virus, and varicella-zoster virus [11].

### Antifungal activity

The majority of people only associate fungi with superficial fungal infections or the decomposition of organic materials,

however fungi can also cause a wide range of human diseases, from minor to well-established systemic diseases, and the most severe infections can even be fatal [11].

Honey has been shown to have an antifungal effect on Aspergillus, Penicillium, all common dermatophytes, Candida albicans, Candida glabrata, and Candida dubliniensis [12].

Candida albicans and Candida glabrata were substantially more susceptible to the antifungal effects of floral honeys than artificial honey [11].

Particularly in patients with vulvovaginal candidiasis during pregnancy, the combination of honey and mucus can be utilised as a complement to or an alternative to antifungal agents [11].

The research' usage of honey samples revealed diverse and encouraging antifungal activity. Nigerian honey could be used as a source of antifungal for the eventual creation of antifungal medications for the treatment of fungal infections: [11].

### Anti-inflammatory activity

Simply put, inflammation is the body's natural defensive mechanism against damage to a tissue, and it involves the mobilisation of leucocytes and blood plasma proteins. Inflammation is characterised by edoema, erythema, discomfort, and elevated body temperature; this damage may be brought on by physical, chemical, or even microbiological causes [11].

Numerous substances found in honey have anti-inflammatory properties, including phenolic derivatives, which may be crucial to the anti-inflammatory actions [5].

A recent study found that honey has an anti-inflammatory impact via reducing the activities of cyclooxygenase-1 and cyclooxygenase-2 [3].

The current body of research indicates that using animal models, cell cultures, and clinical trials, honey lowers the inflammatory response [1].

Consuming diluted natural honey had a lowering effect on plasma levels of prostaglandins like PGE2, PGF2, and thromboxane B2 in healthy people. Reduced edoema, fewer granular and mononuclear cell infiltration, less necrosis, improved wound contraction, improved epithelization, and low glycosaminoglycan and proteoglycan concentrations are all signs of honey treatment for lesions. Additionally, it lessens exudation and inflammation, speeds up healing, minimises scar size, and promotes tissue regeneration. Eczema, psoriasis, and dandruff have also been reported to be treated with honey [3].

Applying honey to wounds has been shown to have a calming effect and to lessen burn pain. In certain instances, local pain is quickly reduced. [25] Honey contains anti-inflammatory properties without causing any negative side effects [3].

### Anticancer activity

According to recent research, honey may fight cancer through a variety of processes. As per research, honey inhibits a number of cell signalling pathways, including those that cause apoptosis, antimutagenic effects, antiproliferative effects, and anti-inflammatory effects. Immune responses are altered by honey [1].

In several types of cancer, including skin cancer cells (melanoma), adenocarcinoma epithelial cells, cervical cancer cells, endometrial cancer cells, liver cancer cells,

colorectal cancer cells, prostate cancer cells, renal cell carcinoma, bladder cancer cells, human non-small cell lung cancer cells, and osteosarcoma cells, honey has been shown to inhibit cell proliferation, induce apoptosis, modify cell cycle progression, and cause mitochondrial membrane depolarization<sup>[1]</sup>.

Additionally, honey may be able to prevent a variety of tumour types in animal models, including bladder cancer, hepatic cancer, melanoma, colon cancer, breast cancer, and carcinoma<sup>[1]</sup>.

A study using the bladder cancer cell lines T24, RT4, 253J, and MBT2 found that honey had an *in vitro* anti-proliferative impact. Similar research demonstrated that honey contains caffeic acid phenyl esters (CAPE), which activate the caspase-3 enzyme and cause cells to undergo apoptosis by stopping the proliferation of malignant cells in the sub-G1 phase of their cell cycle<sup>[4]</sup>.

Citrus honey demonstrated the highest cytotoxic activity against breast cancer, while Ziziphus honey demonstrated potent efficacy against colon, liver, and breast cancer. Cassia honey demonstrated moderate cytotoxic activity against colon cancer and breast cancer, with the weakest cytotoxic activity against liver cancer. Another form of honey, Manuka honey, was also examined because it was the sort of cancer that strikes and kills women most frequently, and the results revealed that it is cytotoxic to MCF-7 breast cancer cells *in vitro*<sup>[11]</sup>.

Additionally to all the anticancer properties, honey also has a high concentration of glucose and a variety of vitamins, minerals, and amino acids, it may encourage the growth of tumours. Additionally, the elevated osmolarity causes lymph to drain. Its acidity encourages the release of oxygen from haemoglobin in the capillaries of nearby tissue, which improves nutrition and oxygenation<sup>[4]</sup>.

### Apoptotic activity

Inadequate apoptotic turnover and unchecked cellular growth are traits of cancer cells. Apoptosis inducers are substances used in the therapy of cancer. In many different types of cancer cells, honey induces apoptosis through depolarizing the mitochondrial membrane<sup>[1]</sup>.

Due to its high phenolic content, honey enhances caspase 3 activation and poly (ADP-ribose) polymerase (PARP) cleavage in human colon cancer cell lines. Additionally, it induces apoptosis in colon cancer via regulating the production of pro- and anti-apoptotic proteins. In addition to up-regulating the expression of pro-apoptotic proteins Bax, caspase 3, and p53, honey also down-regulates the expression of the antiapoptotic protein Bcl2<sup>[13]</sup>.

Manuka honey administered intravenously induces apoptosis in cancer cell lines by activating caspase 9, which in turn activates caspase 3, the executioner protein. Manuka honey induces apoptosis via activating PARP, fragmenting DNA, and suppressing the expression of Bcl2.

Since many of the existing chemotherapeutics are apoptosis inducers, honey's apoptotic qualities make it a potential natural anti-cancer agent<sup>[1]</sup>.

### Health benefits of honey in various fields.

#### Wound healing

In contrast to other modern compounds that have failed in this regard, honey is the oldest wound- healing substance known to humans<sup>[1]</sup>.

The ancient doctors were aware of variations in the therapeutic value of the honeys that were available to them. Aristotle (384–322 BC), discussing variations in honeys, referred to pale honey as being "good as a salve for sore eyes and wounds," and Dioscorides (c. 50 AD) stated that a pale yellow honey from Attica was the best, being "good for all rotten and hollow ulcers."<sup>[8]</sup>

The use of honey therapy has been found to be effective for almost all types of wounds, including abrasions, abscesses, amputations, bed sores/decubitus ulcers, burns, chill blains, burst abdominal wounds, cracked nipples, fistulas, diabetic, malignant, leprosy, traumatic, cervical, varicose and sickle cell ulcers, septic wounds, surgical wounds<sup>[3]</sup>

The efficacy will depend on the type of wound and its severity. Use enough of a particular honey to stay in the area even after being diluted with wound exudates. It need to encompass and go beyond the edges of the wound. When applied to a dressing rather than a wound, the results are better. To stop bleeding from the wound, apply an occlusive bandage after thoroughly filling all the cavities with honey<sup>[3]</sup>.

Honey's high sugar content, low moisture level, gluconic acid, which creates an acidic environment, and hydrogen peroxide are its four main antibacterial qualities. Another benefit of honey for wounds is that it lessens swelling and oedema and speeds up the recovery from passive hyperaemia. When applied to wounds, honey soothes discomfort and lessens burn pain in situations when local pain is rapidly diminished<sup>[2]</sup>.

According to reports, when honey is used as a dressing, sloughs, gangrenous tissue, and necrotic tissue are quickly replaced with granulation tissue and progressive epithelialization, necessitating the least amount of surgical debridement possible<sup>[2]</sup>.

Topical honey application speeds up bacterial eradication, lowers the need for antibiotics and hospital stays, promotes wound healing, and leaves less scars in patients with postoperative wound infections after caesarean section or hysterectomies<sup>[3]</sup>.

#### Diabetes

In comparison to glucose or sucrose in cases of typical diabetes, the consumption of honey in type I and type II diabetes was linked to a much reduced glycaemic index. Honey raised plasma glucose levels in diabetic individuals much less than dextrose did. In both normal and hyperlipidemic participants, it also led to a decrease in blood lipids, homocysteine levels, and C- reactive protein (CRP) levels. In prior studies, it was discovered that honey increases haemoglobin concentration, stimulates insulin secretion, lowers blood glucose levels, and improves lipid profiles<sup>[1,3]</sup>.

Additionally, honey may be a suitable sweetener for the type II diabetic diet, according to a clinical trial by Katsilambros *et al.*, since adding fat-rich meals to honey raises the levels of triglycerides and insulin in the blood<sup>[7]</sup>.

LDL-C and cholesterol were lowered by glucose. Artificial honey increased TG while marginally lowering cholesterol and LDL-C. Honey increased HDL-C marginally while lowering cholesterol, LDL-C, and TG. Artificial honey raised TG while honey lowered TG in patients with hypertriglyceridemia. Artificial honey raised LDL-C while honey lowered LDL-C in patients with hyperlipidemia.

Compared to dextrose, honey significantly reduced the rise in plasma glucose in diabetic patients [5].

With a lower GI, the acacia and yellow box varieties of honey have a significantly higher fructose concentration. According to the GI concept, carbohydrates play a function in disorders of the metabolism and the endocrine system as well as in good health. Consuming honey with a low GI, such as acacia honey, has physiologically beneficial effects and may be used by people with compromised endocrine function [10].

### Cardiovascular disease

Flavonoids, polyphenolics, Vitamin C, and monophenolics—all antioxidants found in honey—might be linked to a lower risk of cardiovascular failure. With regard to coronary heart disease, flavonoids' protective effects, such as their antioxidant, antithrombotic, anti-ischemic, and vasorelaxant properties, lower the risk of coronary heart disorders via three mechanisms: (a) increased coronary vasodilatation; (b) decreased blood platelet clotting; and (c) inhibition of low-density lipoprotein oxidation. Although there are many various kinds of antioxidants, different varieties of honeys tend to be higher in caffeic acid, quercetin, phenethyl ester, kaempferol, galangin, and acacetin. Numerous studies shown that some honey polyphenols may have a positive pharmacological effect in lowering cardiovascular diseases [1, 3].

Increased levels of NO in honey may have a protective effect against cardiovascular illnesses. Nitric oxide (NO) metabolites can be found in honey. Additionally, honey reduced venous blood pressure, which could lessen the preload on the heart and, in turn, could alleviate venous congestion [3].

Another *in vitro* study's findings demonstrated that prolonged oral administration of natural honey to rats for 45 days leads in significant anti-arrhythmic and anti-infarct benefits. Along with inhibiting oxidative stress, honey has neuroprotective properties against *in vitro* cell death and *in vivo* localised cerebral ischemia.

### Gastrointestinal disease

It has been claimed that honey can be taken orally to cure and prevent gastrointestinal infections brought on by bacteria and rotavirus, including gastritis, duodenitis, and stomach ulceration.

There are a number of factors that could account for honey's ability to reduce bacterial adherence:

(a) non-specific mechanical inhibition possibly caused by the honey coating the bacteria; (b) some fractions of the honey may change the bacterial electrostatic charge or hydrophobicity, which have been reported to be crucial elements in the interaction of bacteria with host cells; or (c) the honey's antibacterial components, which have been mentioned earlier, may kill the bacteria [3].

Honey is found to help diarrhoea and gastroenteritis resolve quickly. In cases of bacterial gastroenteritis, honey at a concentration of 5% (v/v) reduced the length of diarrhoea compared to the group receiving sugar as a replacement fluid. Honey increases potassium and water absorption while decreasing salt absorption in rehydration fluid.

Indomethacin-induced gastric lesions, microvascular permeability, and stomach myeloperoxidase activity were all inhibited by oral pretreatment with honey (2 g/kg).

Additionally, it has been proposed that natural honey can be utilised to treat peptic ulcer illness like sucralfate and has healing effects for antral ulcers [3].

### Infections

According to some reports, honey inhibits the growth of fungus. Both pure and diluted honey appear to be able to stop the formation of toxins and fungal development. Honey has been reported to be effective in treating cutaneous and superficial mycoses including ringworm and athlete's foot. Additionally, according to some research, applying honey topically to treat dandruff and seborrheic dermatitis is helpful [3].

According to reports, honey is particularly good at treating infected wounds. Honey prevents the spread of the infection without requiring the removal of dead tissue [25].

### Ophthalmology

Aristotle wrote in 350 BC in section 627a of *Historic Animalium* that 'White honey is good as a salve for sore eyes'. Lotus honey was once believed to be a cure-all for eye ailments in India. In order to avoid the corneal scarring that results from this infection, honey is also used as a traditional treatment for measles in Mali. Meier mentioned using honey to cure eyes that were oozing pus. It has also been claimed that keratitis (inflammation of the cornea), catarrhal conjunctivitis, and blepharitis (inflammation of the eyelids) can also be treated with honey [25].

It was demonstrated that honey may be used to heal corneal ulcers, corneal injuries, syphilitic keratitis, and lime burns to the cornea. Additionally, it stated that several cases of scrofulous keratitis had responded to treatment with pure honey. It also documented a case where a lime burn of the cornea was treated with pure honey, with half-vision being returned in 12 days [3, 25].

When honey is administered to the eye under the lower eyelid, anti-inflammatory, antibacterial, and anti-fungal effects are observed. It has been used undiluted or as a 20–50% solution in water for corneal infections, conjunctivitis, and chemical and thermal burns to the eye [25].

Application of honey to infected conjunctivitis sped up bacterial eradication time and decreased redness, swelling, and pus discharge [3].

### Cough and Asthma

Cough is one of the most common symptoms made to practically all general physicians and is a big worry for everyone. Children frequently experience coughing, which has a variety of etiopathological factors, including age, location, environment, weather, and epidemiological circumstances. Children's etio-pathology of cough is different from that of young adults. Children are more vulnerable to the negative impacts than adults are. Due to their underdeveloped immune systems, children are more susceptible to many diseases that are accompanied by persistent or protracted coughing. The cough frequency therapy resulted in honey consistently score being significantly better. Honey has positive effects on cough prevention and a great safety record. Honey works better for treating the symptoms of a nighttime cough and sleep issues related to an upper respiratory infection in children [10].

Folk medicine frequently uses honey to cure fever, coughs, and inflammation. It has been demonstrated that honey can

reduce asthma-related symptoms or act as a preventative measure to stop asthma from developing. In animal modelling, oral honey ingestion was used to treat chronic bronchitis and bronchial asthma. In addition, a study by Kamaruzaman *et al.* Shown that therapy with honey substantially reduced asthma-related histological alterations in the airways and decreased the development of asthma by inhibiting ovalbumin-induced airway inflammation. Honey has also been found to be an effective way to treat goblet cell hyperplasia, which secretes mucus <sup>[1]</sup>.

### Food preservatives and prebiotic

*Shigella*, *Listeria monocytogenes*, and *Staph. Aureus* development has been reported to be inhibited by hydrogen peroxide and non-peroxide components such as antioxidants, aiding in food preservation. On the other hand, honey might contain trace levels of *Clostridium botulinum*. It has a strong chance of being employed as a natural source of antioxidants to lessen the effects of polyphenol oxidase browning on the processing of fruits and vegetables. A prebiotic is a non-digestible dietary supplement that alters the composition of the intestinal microbiota by promoting the development and activity of helpful organisms while inhibiting the growth and activity of potentially harmful bacteria.

In fermented milk products, honey has been found to be a suitable sweetener that doesn't prevent the growth of common bacteria like *Strep. Thermophilus*, *Lactobacillus acidophilus*, *Lacto. Delbrueckii*, and *Bifidobacterium bifidum*, which are crucial for maintaining the health of the gastrointestinal tract. Due to the presence of a variety of oligosaccharides, honey also promoted and supported the growth of *bifidobacterium* <sup>[3]</sup>.

### Neurological Disease

Honey is one such promising nutraceutical antioxidant that has been extensively studied in the scientific literature as innovative neuroprotective therapeutics. Honey reduces the oxidative content of the central nervous system and has anxiolytic, depressive, anticonvulsant, and antinociceptive properties.

According to a number of studies, honey polyphenols may have nootropic and neuroprotective effects. The biological ROS that cause neurotoxicity, ageing, and the pathological buildup of misfolded proteins, such as amyloid beta, are squelched by the polyphenol components of honey. Honey's polyphenolic components, which include excitotoxins like quinolinic acid and kainic acid as well as neurotoxins like 5 S-cysteinyldopamine and 1 methyl 4 phenyl 1, 2, 3, 6 tetrahydropyridine, work to reduce oxidative stress.

Additionally, components of honey's polyphenols protect against direct apoptotic threats such as retinoid, methyl mercury-induced, and amyloid beta. The microglia-induced neuroinflammation brought on by immunogenic neurotoxins or ischemic damage is lessened by raw honey and honey polyphenol. The hippocampus, a part of the brain involved in memory, is the brain region where honey polyphenols have the greatest impact on reducing neuroinflammation. The molecular synthesis of memory is induced and prevented by honey polyphenols. Several studies contend that the memory-improving and neuropharmacological effects of honey are caused by alterations to particular brain circuits <sup>[1]</sup>.

### Fertility

In the past, Egyptians offered honey to promote fertility. Additionally, honey was traditionally consumed by many civilizations to increase male virility. Infertility can have a variety of reasons, as well as potential treatments. Numerous studies have revealed that honey bee pollen is believed to enhance egg quality as well as general fertility and fecundity due to its rich supply of vitamins, iron, calcium, minerals, amino acids, and immune-enhancing qualities. Honey has been recommended for both men and women with infertility-related issues, such as irregular ovulation. Drinking warm milk with honey is thought to significantly increase sperm count in infertile or subfertile males. Vitamin B is known to be abundant in honey and is necessary for the synthesis of testosterone <sup>[10]</sup>.

A positive association between consumption of honey and testosterone levels has been noted in some academic studies. It has been hypothesised that honey's high concentration of nitric oxide, a chemical compound involved in vasodilatation, can induce and improve erection in men with dysfunctional erection or impotence. It has been demonstrated that 100 grammes of honey is all that is needed to boost blood levels of nitric oxide by up to 50%. According to teachings in complementary and alternative medicine, honey enhances the quality of sperm in males and fortifies the ovaries and uterus in women. In a recent study, authors found that adding honey to a cryoprotectant solution improves the general quality of the sperm <sup>[10]</sup>.

### Replacement of radiotherapy as cancer treatment

Mammary cancer in their study, Tsiapara *et al.* Assessed how Greek thyme, fir, and pine honey extracts affected the viability and regulation of estrogenic activity in MCF-7 breast cancer cells. Depending on their concentrations, the honey samples exhibited biphasic activity, according to their findings. In particular, the extracts showed estrogenic action at high doses and an antiestrogenic impact at low ones. Pine and thyme honey (THH) has antiestrogenic effects when estradiol is present, whereas fir honey extract makes MCF-7 cells more estrogenic. Additionally, neither pine nor THH affected the vitality of MCF-7 cells; rather, fir honey made these cells more viable. Due to the extracts' high concentrations of phenolic components like quercetin and kaempferol, these dual actions are probably the result. Numerous earlier research have documented these complementary effects of phenolic polyphenols and other phytoestrogens <sup>[12]</sup>.

Liver tumouran experiment's findings revealed that honey treatment of human hepatocellular carcinoma (hepg2) cells might significantly lower nitric oxide levels and the number of viable hepg2 cells while boosting overall antioxidant status. According to these results, it appears that reactive oxygen species are necessary for hepg2 cell viability (ROS). Therefore, honey's reduction of ROS and enhancement of antioxidant defence result in the suppression of proliferation and a reduction in the number of hepg2 cells that are still viable. 3 In a study using hepg2 cells, Baiomy *et al.* Discovered that honey extracts exhibit cytotoxic, anti-angiogenic, and antimetastatic properties. Nevertheless, the strength of these effects differs according to the calibre of the honey utilised <sup>[12]</sup>.

### Adverse effects of honey

The negative effects of honey are minimal. Application of honey topically may provide a brief stinging sensation.

Other than that, it's variously described as being calming, alleviating pain, non-irritating, and a painless dressing change. Although allergic reactions to pollen or bee proteins in honey are uncommon, they are possible. The tissues may get dehydrated from excessive honey application, but saline packs can restore the tissues' moisture content. When applied to a big open wound in a diabetic, there is always a theoretical risk of a spike in blood glucose levels. Gamma irradiation, which kills the spores of clostridia without reducing their antibacterial activity, can reduce the risk of wound botulism caused by the presence of Clostridia [3].

#### Recent medicinal research on honey

**Hair loss:** Before taking a bath, those experiencing baldness or hair loss should apply a paste made of one tablespoon of hot olive oil, one teaspoon of honey, and one teaspoon of cinnamon powder. After that, wash your hair. Even if left for 5 minutes, it was proven to be quite beneficial.

**Bladder infections:** Take two tablespoons of cinnamon powder and one teaspoon of honey and mix them in a glass of lukewarm water to treat bladder infections. It eliminates bladder bacteria.

**Toothache:** Apply a paste made of five teaspoons of honey and one teaspoon cinnamon powder to the painful tooth. Until the tooth stops grinding, this can be done three times every day.

**Cholesterol:** The amount of cholesterol in the body is reduced by 10% after two hours when two tablespoons of honey and three teaspoons of cinnamon powder are combined in 16 ounces of tea water and given to a patient with high cholesterol.

**Colds:** For three days, take one tablespoon of Luke warm honey and 1/4 teaspoon of cinnamon powder if you have a common or severe cold. Most persistent coughs, colds, and sinus congestion will be cured by this approach.

**Stomach ache:** Honey combined with cinnamon powder relieves indigestion and removes stomach ulcers from the source.

**Immune system:** Regular use of honey and cinnamon powder boosts defence mechanisms and shields the body from viral and bacterial infections.

**Indigestion:** An indigestion remedy that lowers acidity and aids in the digestion of even the heaviest meals is two tablespoons of honey mixed with cinnamon powder.

**Influenza:** A Spanish researcher has established that honey includes a natural component that kills influenza viruses and protects the patient from the illness.

**Longevity:** When consumed consistently, tea prepared with honey and cinnamon powder stops the effects of ageing. It delays ageing and maintains the skin smooth and healthy.

**Weight loss:** Consume honey and cinnamon powder cooked in one cup of water every day, half an hour before breakfast on an empty stomach, and right before bed. Even the most obese individual can lose weight with frequent use. The

regular consumption of this mixture also prevents fat from building up in the body, despite the fact that the individual may consume a high-calorie diet.

#### Conclusion

Honey and its constituents have a wide range of uses as a natural substance with good pharmacological and medicinal qualities, including the treatment of atherosclerosis, neurological diseases, and wound and skin healing. Although there has been a noticeable increase in publications since 1990 and interest in the health benefits of honey and its constituent such as propolis, more clinical trials are urgently required to establish the substance's benefits for a given population. Even though more human studies are necessary, the preclinical evidence strongly suggests that honey plays a role in antioxidant and anti-inflammatory activity, which may help to reduce the risk of a number of chronic diseases like heart disease, diabetes, hypertension, and neuronal degenerative diseases like Alzheimer's [23].

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