

Chemistry and Pharmacology of Honey

Kamal Shah¹, Sumit Chhabra¹, Nagendra Singh Chauhan^{2,*}

ABSTRACT

Honey which is obtained from *Apis mellifera* has wide uses due to its chemical constituents present in it. World Wide honey is used for nutritious and medicinal purposes. The review would give the platform to the readers, researchers, scholars to have clear view of the chemical components, its probable mechanism, pharmacological activity and comparison of its ancient uses. Apart from pharmacological, nutritional and non-nutritional components its side effects are also discussed. This review would be an insight for the researchers in the field of medicine.

Keywords: Honey, Pharmacological, Adverse effects, Nutritional, Non-nutritional, Anti-oxidant.

INTRODUCTION

Honeybees (*Apis mellifera*; Family: Apidae) forms a product from sap of plants which is also known as Honey^[1] From 5500 years, honey has been used by humans.^[2] Honey has been used by maximum ancient people for nourishing objects and as well as for its remedial goods.^[2-3] Honey is the solitary bug consequent product, and it has nutritious, beautifying, medical, and business standards.^[4-5] As per a study says honey is used as a well-adjusted nourishment and equally widespread in all ages of male and female.^[6] Honey can store at room temperature without any spoilage. The pH value of honey is 3.9 and water activity is between 0.56 and 0.62.^[7-8] Furthermore, the practice of honey in drinks is also gradually widespread.^[8] Currently, many magazines, journal and natural product's leaflets are publishing unknown activities of honey.^[9] Publication specifies that honey can apply numerous healthvaluable properties together with antioxidant,^[10] used against inflammation,^[11] bacterial infections,^[12] diabetes^[13] respiratory, gastrointestinal^[14] troubles, heart related problems, and nervous system^[15] protective properties.

Categories of Honey

Now, honey can be divided into two types i.e., blossom or nectar honey (floral origin), based on its origin. Nectar honey which has flowered source may be unifloral or multifloral. There is one more kind of honey called honeydew which is obtained from the discharges of floras or bugs which are slurped by bees. It is an unconventional type of honey.^[16] Manuka honey is a kind of monofloral honey, has antimicrobial and antioxidant properties due to which it has its own significance. This category of honey is got from a manuka tree which is also known as a *Leptospermum scoparium* (Myrtaceae), is commonly found in New Zealand and eastern Australia.^[17]

Nutritional and Non-nutritional Components of Honey

Based on different kinds of nectar collected by honeybees, we can say about 300 kinds of honey have been identified in recent world.^[18] Honey is mainly consisting of carbohydrate. The key alignment of honey is carbohydrates that subsidize 95–97% of its dehydrated mass. Additionally, it contains key molecules, such as proteins, vitamins, amino acids, minerals, and organic acids.^[19-20] Flavonoids, polyphenols, reducing compounds, alkaloids, glycosides, cardiac glycosides, anthraquinone, and volatile compounds are also constituents of pure honey.^[21-23] Nutritious and corporeal properties of honey is mainly due to ketose sugar fructose and aldose sugar glucose which are monosaccharides, which are the utmost vital part of honey.^[24] Disaccharides, trisaccharide and oligosaccharides are present in honey in a smaller quantity.^[25-26] During the process of ripening and maturation of honey, many of these sugars are formed. Organic acids i.e., gluconic acid, acetic acid, formic acid, and citric acid have also been found in honey.^[27] Acidic nature of honey (pH between 3.2 and 4.5) is due to these organic acids.^[28] It also comprises of few significant amino acids,^[29] enzymes,^[30] vitamins and approximately 31 variable minerals such as phosphorus, sodium, calcium, potassium, sulfur, magnesium, and chlorine.^[31] Earlier literatures have spotted the nearly 600 volatile alignments in it that subsidize to its possible pharmacological properties.^[32] There are two main bioactive constituents of honey which are flavonoids and polyphenols. Current literatures have revealed the existence of approximately 30 types of polyphenols in it. In general, gallic acid,

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syngic acid, ellagic acid, benzoic acid, cinnamic acid, chlorogenic acid, caffeic acid, isorhamnetin, ferulic acids, myricetin, chrysin, coumaric acid, apigenin, quercetin, kaempferol, hesperetin, galangin, catechin, luteolin, and naringenin are the phenolic and flavonoids constituents in honey.^[33-34] The chemical constituents of it have clearly identified, that honey possess role in treatment of cancer, inflammation or in microbial infections that may be due to its antioxidant properties.

Chemistry of Constituents Present in Honey

Flavonoids are 15 carbon compound, including two aromatic rings combined by a pyrane nucleus which is a cluster of dynamic natural molecules.^[35] The obtained flavonoids can be classified into different classes according to their structure, that are flavanols, flavones, flavanones or isoflavones. Honey consists of multiple compounds of these categories like quercetin, luteolin, pinocembrin, pinobanksin, apigenin, naringenin, hesperetin, kaempferol, chrysin, genistein and anthocyanidins.^[36] Figure 1 showed the structure of constituents present in honey.

Physical Characteristics of Natural Honey

Honey is a viscous liquid. The extra properties of honey are hygroscopicity which defines the capacity of honey to captivate and grasp humidity from atmosphere. On the basis of origin of honey, the surface tension of honey differs maybe due to colloidal constituents. The colour in fluid honey differs from clear and colourless (like water) to dark yellowish-brown or black. During crystallization, honey goes nimbler in colour as the glucose crystals are white.^[37]

Uses of natural honey in the past

On the basis of Stone Age paintings, the application of honey by human is outlined to some 8000 years ago.^[38] In ancient time, the people of Egypt, Assyrian, China, Greek and Roman used honey for wound healing and gut's diseases.^[39]

In this section, some medicinal uses of honey are summarised which have been applied by ancient races. In ancient time, human measured honey as a nature's most extraordinary aids to mankind. Honey is a God gift to individuals having low digestion, on the basis of texts of Ayurveda. Likewise, the thing has been highlighted that the practice of it is extremely helpful in the dealing of exasperating cough. It is observed

by Ayurvedic specialists, as valued in keeping the teeth and gums well. Due to its hypnotic action, it has been applied for periods for the dealing of insomnia. In Ayurveda from a long time, honey is used for several eye disorders. By the application of honey regularly to the eyes, it recovers the eye-sight. Furthermore, honey is observed as valuable in the stoppage of cataract.^[40] It was also present with wine and milk in almost all Egyptian medicines. The early Egyptians presented honey to their deities as a detriment.^[41]

Honey in Current Medicine

Antimicrobial possessions of honey

In the old system of medicine, there was an important role of medicine and during previous few years, it was exposed to test centre and medical research. In 1892, antibacterial activity of honey is described by van Ketel.^[42] The literature supports that the honey has a repressive outcome to about 60 classes of bacteria. It was found to be effective against gram-positives as well gram-negatives micro-organisms.^[37]

Fungal Infections

Honey had been described to inhibit the growth of fungi. Fungal growth is deceased by pure honey and toxin production is also decreased by diluted honey.^[43] An antifungal property had also been detected for some yeast and classes of *Aspergillus* and *Penicillium*, also for common dermatophytes.^[44-45] Honey was also inhibiting the growth of Candidiasis, caused by *Candida albicans*.^[46] In some literature, it had been described that topical use of it has significant outcomes. It can be used in skin infections and for the treatment of dandruff.^[47]

Antiviral Activity of Honey

Honey was also revealed antiviral consequence. In 2004, Al-Waili described the result of the topical use of honey on regular occurrences of herpes abrasions and determined that superficial use of it was harmless and active in the supervision of the signs and symptoms of repeated scratches from lips.^[48]

Ophthalmology effects of honey

Numerous ophthalmological circumstances like inflammation in conjunctiva, cornea, infection in eyelids, any injuries due to chemical or thermal blepharitis, keratitis, conjunctivitis, corneal injuries, chemical and thermal injuries to eyes is treated worldwide by the application of honey.^[49] In conjunctivitis, application of honey decreased the soreness, inflammation, fluid release and time to bacterial abolition.^[38,46,48]

Honey as a food source

Honey is a good food source. It consists of monosaccharides like glucose, fructose besides few higher member sugars. Honey not only contains sugar but also has proteins, vitamins and minerals in rich amount. In some literature, it was described that it is an active sugar source for players before and after confrontation exercise and throughout fortitude exercise.^[38]

Honey as anti-diabetic

Due to lower glycemic index, honey was used in both types of diabetes that is insulin dependent and independent. As equated by dextrose, honey produced a meaningly inferior growth in plasma glucose points in a diabetic person.^[38] In previous studies, it was described that honey rouses insulin discharge, reduce blood glucose levels, raises haemoglobin value and recovers lipid contour.^[48]

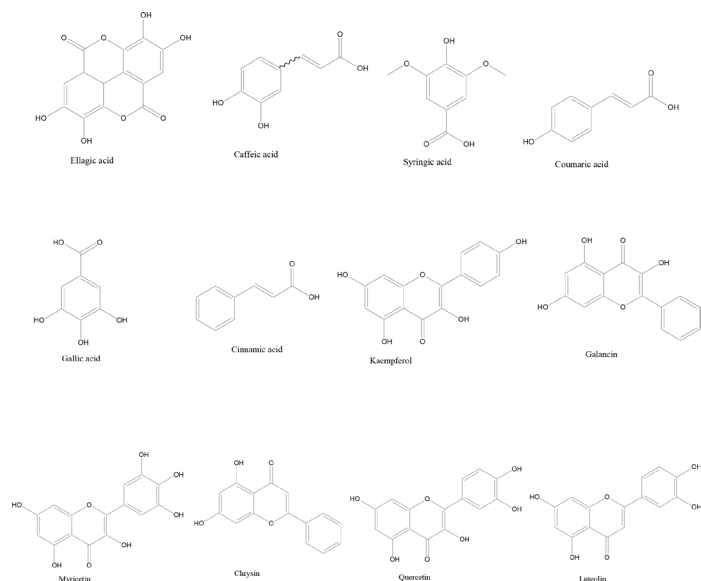


Figure 1: Chemical structures of the flavonoids, organic acids, and phenolic ingredients in honey.

Anti-inflammatory effects of honey

The literature perceive that honey exhibited anti-inflammatory activity by inhibiting the role of cyclooxygenase enzymes 1 and 2.^[50] It was similarly described that diluted honey exposed lessening outcome on absorptions of prostaglandins for example PGE2, PGF2 α and thromboxane B2 in plasma of ordinary persons.^[51]

Other effects of honey

In some studies, honey showed anticarcinogenic activity.^[38] Honey exhibited antineoplastic activity in the experimental bladder cancer.^[52] Chest pain, fatigue and vertigo was also treated by honey. This is possibly due to ingestion of honey; it provides directly available calories after consumption and give high nutritional energy.^[53] Aids of honey had been showed in tooth removal hurt and contagion or cavity owed to radiation-induced xerostomia.^[38]

Adverse effects of honey

There are no severe adverse effects of honey. There might be transient stinging sensation after topical application of honey. Due to pollen or bee proteins in honey, allergic reaction was there in a human body. Unnecessary use of honey might be cause to dryness of tissues which can yet be reinstated by saline packs. There might be a risk of rise in blood sugar due to application of honey on large open wound in diabetics.^[38,54]

Concluding Remarks

In current scenario researchers are trying to make remedies with synthesis free origin and trust that environment friendly goods may be effective medicines in evaluation with the chemically designed products. There is a single natural product i.e., honey which has been applied for various remedial products since earliest times. Now researchers also admit honey as a novel better medication for several types of ailments due to its significant part in the outmoded medication. Honey has a vital role as an antibacterial, antifungal, skin diseases, anti-inflammatory, antineoplastic, etc. In future, researchers will come with more effective results of honey in the field of medicine.

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CONFLICT OF INTEREST

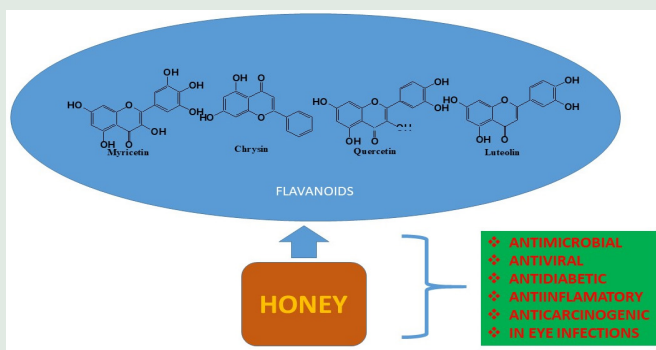
The authors declare no conflict of interest.

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GRAPHICAL ABSTRACT



SUMMARY

The *Apis mellifera* is source of honey. Traditionally honey itself is used for the treatment of various ailments or sometimes given as adjuvant with many drugs. It is one the safest and widely used drug which is known for therapeutic and nutritious value. The review has highlighted the phytochemistry, pharmacology and side effects of honey a in current scenario. The review would be assets for the peoples working in area of phytochemistry and pharmacology. This manuscript potentiates the outcomes and would open the field to work in this area exhaustively. The researchers would be able to do the work more precisely.

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