



## Honey and its multiple uses- A review

Puja\*, Suresh Chandra, Deepali Mudgal and Samsher

Department of Agriculture Engineering, CoPHT&FP, S.V. Patel University of Agriculture and Technology, Meerut-250110 (U.P.), India

\*Email: [pujayadav5544@gmail.com](mailto:pujayadav5544@gmail.com)

### Abstract

Honey is a sweet liquid produced by honey bee (*Apis mellifera*) from nectar of flowering plants that require insect pollination by honey bee. It is produced in approximately every corner of the world and India has been known as 'land of honey'. It is used as direct intake sweetener, to promote higher mental efficiency, as an ingredient for cough mixtures, sedatives ayurvedic medicine etc. due to its great food value and several medicinal qualities. It also improves calcium fixation in bones, curing anemia, anorexia and used by diabetic patients as well. Honey consists at least 200 substances mainly carbohydrates and water. It also contains minerals, proteins, free amino acids, enzymes, vitamins, organic acids, favonoids, phenolic acids, and other phytochemicals. In addition, honey is valuable for the treatment of cardiovascular diseases, cancer, cataract, and several infammatory diseases as well as wound healing. It contains a broad spectrum therapeutic properties such as anti-inflammatory, antibacterial, expedite wound healings, antidiabetic, antiviral, and antifungal effects. Honey also has antioxidant properties. Addition of honey can improve the quality of a variety of food products. Honey cakes, honey cookies and biscuits made with honey have pleasant flavour and are much more nutritious than many of sugar based products. It has been used in formulation of bakery products like bread, ready-to-eat cereal products, cookies, honey fruit spread, sweetened peanut butter spread, microwave cooked chicken patties with honey and honey based ice creams.

**Keywords:** Antibacterial Effects, Honey, Multiple uses, Processing, Physiochemical properties.

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### Introduction

Honey is a sweet liquid produced by honey bee (*Apis mellifera*) from nectar of flowering plants that require insect pollination by honey bee. It is produced in approximately every corner of the world and India has been known as 'land of honey'. It is used as direct intake sweetener, to promote higher mental efficiency, as an ingredient for cough mixtures, sedatives ayurvedic medicine etc. due to its great food value and several medicinal qualities. It also improves calcium fixation in bones, curing

anemia, anorexia and used by diabetic patients as well (Singh *et al.*, 2014).

Honey consists at least 200 substances mainly carbohydrates and water. It also contains minerals, proteins, free amino acids, enzymes, vitamins, organic acids, favonoids, phenolic acids, and other phytochemicals. In addition, honey is valuable for the treatment of cardiovascular diseases, cancer, cataract, and several infammatory diseases as well as wound healing (Azonwade *et al.*, 2018).

Honey is a natural sweetener which increase the value of food due to its high energy

carbohydrate content, considered to be the best source of heat and energy and preferred as vehicle of medicine because it is free from any adverse effect and easy assimilation (Molen, 1992; Durrani *et al.*, 2011).

Honey has been studied against various ailments in animal and human models. It contains a broad spectrum therapeutic properties such as anti-inflammatory (Molan, 2001; Ahmed *et al.*, 2018), antibacterial (Sherlock *et al.*, 2010), antimutagenic (Wang *et al.*, 2002), expedite wound healings (Lusby *et al.*, 2002), antidiabetic (Erejuwa *et al.*, 2010), antiviral (Shahzad and Cohrs, 2012), antifungal (Irish *et al.*, 2006), and antitumoural (Othman, 2012; Swellam *et al.*, 2003; Ghashm *et al.*, 2010) effects. It could be purported as a natural cancer “vaccine” as it decreases chronic inflammation, improves healing of long lasting ulcers and wounds, and improves immune status; the opposite of these are risk factors to cancer formation (Othman, 2012). Its anticancer activity has been proved against various types of cancer: breast (Fukuda *et al.*, 2011; Tsiapara *et al.*, 2009; Gribel and Pashinskiĭ, 1990; Tomasin and Gomes-Marcondes, 2011; Fauzi *et al.*, 2011), colorectal (Jaganathan and Mandal, 2009), renal (Samarghandians *et al.*, 2011), prostate (Tsiapara *et al.*, 2009), endometrial (Tsiapara *et al.*, 2009), cervical (Fauzi *et al.*, 2011), and oral (Ghashm *et al.*, 2010). Honey has the property to reduce cardiovascular risk factors in normal healthy individuals (Yaghoobi *et al.*, 2008). It causes to reduce systolic blood pressure and level of triglycerides and VLDL (very low-density lipoprotein) in experimental animals (Erejuwa *et al.*, 2011). In a randomized clinical trial, lower incidence of acute respiratory symptoms was observed in individuals who took honey on a daily basis (Sulaiman *et al.*, 2011). It improves female hormones (Zaid *et al.*, 2010), increases the percentage of sperms and motility, and reduces the toxic effects on spermatogenesis

and testosterone level (Mohamed *et al.*, 2012; Mahaneem *et al.*, 2011). Postmenopausal women who received honey therapy showed improvement in their immediate memory compared with the improvement seen in women receiving estrogen plus progestin therapy (Othman *et al.*, 2011). Understanding the mode of action of honey is substantial and under phase area.

In Ayurveda, since many centuries honey was used for nutritional and therapeutic purposes both internally and externally. Honey is used as Anupana (is a fluid vehicle taken with or after medicine or eating and which aids or assists the action of main ingredient) with principal drug in Ayurveda clinical practice. It is externally used for the treatment of eye diseases, cutting and burning wounds. Internally used with other herbal preparations specially for respiratory disorders such as cough, asthma and phlegm with or without fever, as a treatment for thirst, vomiting and hiccup, for diabetes, decoctions prescribed with adding bee honey, for obesity specially use old honey, for diarrhea, bee honey added to fresh herbal juice or decoctions specially in traditional medicine. It is also used as a natural preservative and sweetener in many Ayurveda or in traditional medicines such as Navaratna kalka (Anonymous, 1994; Arawwawala and Hewagegana, 2017). It is also used as a vehicle along with some medicines to improve its efficacy or to mitigate the side effects of the other medicines it is mixed with.

Honey also has antioxidant properties (Shamala and Jyothi, 1999). Addition of honey can improve the quality of a variety of food products. Honey cakes, honey cookies and biscuits made with honey have pleasant flavour and are much more nutritious than many of sugar based products (Singh *et al.*, 1988). It has been used in formulation of bakery products like bread (Candert, 1971; Voll, 1974), ready-to-eat

cereal products (Fast *et al.*, 1971; Colangelo, 1980), cookies (Schmidt, 1978), honey fruit spread (Berthold and Benton 1968), sweetened peanut butter spread (Billerback *et al.*, 1976), microwave cooked chicken patties with honey (Naveena *et al.*, 2007) and honey based ice creams (Saxena and Jaiswal, 2005).

Honey is spoken of by all religious books, and accepted by all generations, traditions and civilizations, both ancient and modern. The religion of Islam recommended the use of honey as food and medicine, and an entire chapter called Surah al-Nahl meaning chapter of the Honey Bee was dedicated in the Holy Qur'an (An-Nahl; Al-Madinah and Al-Munawarah, 1990; Kadirvelu, and Gurtu, 2013). In the book of hadith, Prophet Muhammad encouraged the use of honey for curative and healing purposes (Al-Bukhari, 1976). In Christendom, there are references made to the importance of bees and honey in the Bible, and these include the Books of Exodus, Judges, Mathew and Proverbs (The Holy Bible, 1972). Honey has been used in Ayurveda medicine in India for at least 4000 years. The other traditions and civilizations that have long embraced honey include Buddhists and Jews (Crane, 1975; Jones, 2001).

### **Formation of bee's honey**

Bees produce honey by collecting sugar-rich nectar from flowers, which is a clear liquid consisting of nearly 80% water and complex sugars. In the hive, the bees use their 'honey stomachs' to ingest and regurgitate the nectar many times until it is partially digested. They continue this process until the product reaches desired quality. After the final regurgitation, the honeycomb is left unsealed. This partly processed raw honey is still high in water content and natural yeast which, unchecked, would cause fermentation. Raw honey is then stored in honeycomb cells to dry. The process continues as bees inside the hive fan their wings,

creating a strong draft across the honeycomb which enhances evaporation of about 80% of the water from the raw honey. Once dried, the cells of the honeycomb are sealed (capped) with wax to preserve the honey. Ripe honey, as removed from the hive by a beekeeper, has a long shelf life and will not ferment if properly sealed (Wikimedia foundation, 2010; Ediriweera and Premarathna, 2018).

### **Extraction of bee's honey**

There are two methods to extract Bee's Honey. The traditional method is to calm or chase the bees away by introducing smoke into the beehive. When the bees have left the beehive or fully calm down, the combs are taken out and squeezed to drain the honey. Some people place the combs in a metallic bowl which has a hole at the base. Burning embers are put on the combs. Honey and beeswax melt and drains down the hole and is collected (Aidoo, 2005; Ediriweera and Premarathna, 2018).

Other method is to use a mechanical honey extractor. This extracts honey without destroying the comb. Extractors work by centrifugal force. A container holds a frame basket which spins, flinging the honey out. With this method, the wax comb stays intact within the frame and can be reused by the bees.

### **Production of Honey**

The honey bee (*Apis mellifera*) is of great importance for humans as a pollinator of both commercial and domestic crops and provider of honey, a high-value nutritional commodity (Potts *et al.*, 2010; Ratnieks and Carreck, 2010; Saranraj and Sivasakthi, 2018). Honey bee loss due to the interacting drivers of pests and diseases, exposure to agrochemicals, apicultural mismanagement and lack of genetic diversity have led to widespread concern about the future potential of honey bees to provide these services

(Ratnieks and Carreck, 2010; Potts *et al.*, 2010). The quality and composition of honey produced is affected by many factors including flower composition, geographical position of the hive, bee health and annual changes in local flora and flowering phenology (Galimberti *et al.*, 2014). Various physical types of honey are also commercially available (comb, chunk, crystallized or granulated, creamed) with many different levels of processing (pressed, centrifuged, drained, heat processed) (Anklam, 1998). Within a honey bee hive there are three castes—queen (alpha), worker (beta) and drone (gamma) bees (Havenhand, 2010), a collective effort allows for the production of honey. Honey is produced by honey bees using nectar from flowering plants, nectar is a sugar-rich liquid that is produced in glands called nectaries.

Nectar is collected by worker bees, travelling up to 9 km in one trip (Havenhand, 2010). Sucrose in nectar is hydrolyzed to produce glucose and fructose (Kubota *et al.*, 2004). Upon return to the hive the nectar is swallowed and regurgitated by thousands of worker bees within the honey comb. The regurgitation process and wing fanning causes evaporation and the water content is reduced, the honey is ripened over time. Honey bees keep the honey as food stores for the winter period when no nectar or pollen is available. Any excess honey can be extracted for human consumption (Havenhand, 2010; Kubota *et al.*, 2004) described how glucosidase III is produced in the hypopharyngeal gland of European honey bees. This enzyme is secreted into the nectar and is responsible for the production of hydrogen peroxide (Bucekova *et al.*, 2014). Pollen grains are collected by honey bees as they visit flowering plants to feed honey bee larvae (Galimberti *et al.*, 2014). Dense pollen pellets are produced from these grains using a nectar-saliva mixture. Honey bees collect the exudate from sap-

sucking insects as an alternative to nectar. Honeydew collection is often recorded from sap feeding insects feeding on conifers and other anemophilous species (Oddo *et al.*, 2004). Tree resin is also actively collected from a range of species and combined with wax to make propolis that is deposited within the hive as it has antimicrobial properties (Wilson *et al.*, 2013).

### Traditional Uses of Honey

Over 4000 years ago, honey was used as a traditional Ayurveda medicine, where it was thought to be effective to balance the three humors of the body. The ancients of Vedic civilization considered honey as one of nature's most remarkable gifts to mankind. In pre-Ancient Egyptian times, honey was used topically to treat wounds (Megan Ware, 2015). Honey is known as Madhu or Kshaudra in Ayurveda scriptures and is one of the most important medicines used in Ayurveda. Synonyms of bee's honey in Sanskrit are Madhu, Madvika, Kshaudra, Saradha, Makshika, Vantha, Varati, Bhrungavantha, and Pushparasodbhava. It is called Meepeni in Sinhala and Thein paani in Tamil (Anonymous, 1994). The ancient Greeks believed that consumption of honey could help one to live longer. Modern research indicates this substance does possess unique nutritional and medicinal properties. Bees honey is categorized into different types in Ayurveda medicinal system. According to Susruta Samhita of Ayurveda, there are eight different types of honey (Jadavaji *et al.*, 2002). Sushruta Samhita is an ancient Sanskrit text on Ayurveda medicine and surgery.

- **Pauttika:** It has dry, hot and potency properties. Pauttika honey is formed from poisonous flowers and leads to vitiation of Vata, Pitta and Rakta (blood).
- **Bhramara:** This type of honey is described as heavy, which means not

easily to digest. It contains slimy and excessively sweet properties.

- **Kshaudra:** This type is known as light, which means easily to digest. It has cold and anti-obesive properties.
- **Makshika:** It is the best honey and especially used for the management of cough and asthma.
- **Chatra:** It has a sweet taste after digestion. Chatra honey also heavy, which means not easily to digest. It has cold and slimy properties. It is given as a remedy for bleeding disorders, leukoderma, urethritic discharges, and worm infestations.
- **Ardhya:** It has a pungent taste after digestion. Ardhya honey is good for eyes, eliminates vitiated Kapha and Pitta Dosha
- **Auddalaka:** It has bestowed taste and beneficial for voice. It also used as remedy for skin diseases. As Ardhya honey, it has a pungent taste after digestion
- **Dala:** It is dry and controls vomiting and diabetes mellitus.

According to Dash and Charaka Samhita which is an ancient Sanskrit text on Ayurveda medicine and surgery, there are four different types of honey such as Makshika, Bhramara, Kshaudra and Paittaka. Makshika is the best type of honey and color is similar to sesame oil. It is produced by reddish variety of honey bees. Bhramara honey is produced by the Bhramara type of bees. It is heavy and white in color. Kshaudra honey is brown in color and produced by a small type of honey bee. Paittaka honey is produced by a large type of bees, and the color is similar to ghee (Dash and Samhita, 1972; Arawwawala and Hewageegana, 2017).

## Recent trends in Honey Processing

**Heating:** Heating is the basic processing treatment of bee honey. The principal objective of heating is to change the state of the product from solid to liquid. Additionally, when properly combined with filtration, it prolongs the re-crystallization of honey. The effect of heating and filtration on honey re-crystallization has been generally recognized for all long time. Based on those two treatments, a number of methods were developed which are devised 5 to maximize the duration of the liquid state of the product. Another method recommends heating honey up to 77°C for 5 min. and, subsequently, filtering it carefully and cooling down rapidly to room temperature. There is yet another approach to honey processing that makes honey stay liquid for a long time, a method that additionally makes use of small quantities of water being added at the initial heating stage to facilitate the dissolution of crystals (Bakier, 2004; National Honey Board). The use of excessive heat in honey processing for liquefaction or pasteurization, however, has adverse effects on honey quality, i.e. loss of volatile compounds, accumulation of HMF and reduction of invertase and diastase activities. However, it should be noted that improper storage of honey leads also to similar changes of HMF and enzyme activity.

**Honey filtration:** Honey should not be strained with a mesh size smaller than 0.2m in order to prevent pollen removal. On the other hand, the recently revised Codex Alimentarius Honey Standard (Codex Alimentarius Commission, 2001) and EU Directive relating to honey (Revised Codex Standard for honey Codex standard, 2001; The Council of European Union Council Directive, 2002) allow a removal of pollen if it is unavoidable for the removal of foreign matter. Such honey should be labeled as “filtered”. Since microscopical pollen analysis is still the most important tool for the determination of botanical and geographical origin of honey, any removal of pollen by

filtration will make authenticity routine testing much more difficult, if not impossible.

**Fermentation:** Harvesting of honey with high moisture content, or subsequent addition of water can result in honey fermentation and spoilage. Honey spoilage can be first tested by a microscopic yeast count. This test on its own does not yield conclusive results, as counted yeast could be in an inactive status not taking part in the fermentation process. Determination of the fermentation products is more reliable, i.e. by determining the glycerol or ethanol content (Bogdanov and Gallmann, 2008; Gangwar, 2016).

### Physical properties of natural honey

Honey has several important qualities in addition to composition and taste. Freshly extracted honey is a viscous liquid. Its viscosity depends on large variety of substances and therefore varies with its composition and particularly with its water content. Hygroscopicity is another property of honey and describes the ability of honey to absorb and hold moisture from environment. Normal honey with water content of 18.8% or less will absorb moisture from air of a relative humidity of above 60%.

The color in liquid honey varies from clear and colorless (like water) to dark amber or black. The various honey colors are basically all shades of yellow and amber. Color varies with botanical origin, age, and storage conditions, but transparency or clarity depends on the amount of suspended particles such as pollen (Olaitan *et al.*, 2007). Less common honey colors are bright yellow (sunflower), reddish undertones (chest

nut), grayish (eucalyptus) and greenish (honeydew). Once crystallized, honey turns lighter in color because the glucose crystals are white. Honey crystallization results from the formation of monohydrate glucose crystals, which vary in number, shape, dimension, and quality with the honey composition and storage conditions. The lower the water and the higher the glucose content of honey, the faster the crystallization (Olaitan *et al.*, 2007; Eteraf-Oskouei and Najafi, 2013).

### Composition and Physiochemical Properties of Honey

Honey characterized by its specific physical properties which include high acidity with a pH value of 3.55-4.00, high color intensity and 1.335 specific gravity. Chemically, it contains phenolic acids and flavonoids. Gallic, syringic, benzoic, transcinamic, p-coumaric, and caffeic acids constitute the phenolic acids of honey. Whereas catechin, kaempferol, naringenin, luteolin and apigenin constitute its flavonoids components. Amongst the various types of Malaysian honey, tualang honey is the richest in phenolic acids, and flavonoid compounds which have strong free radical-scavenging activities. Ahmed, *et al.*, 2013 reported the presence of some compounds that are specific to honey among the other types of honey. stearic acids, 2-cyclopentene-1, 4,-dione, 2[3H]-furanone or dihydro-butylolactone, gamma-crotonolactone or 2[5H]- furanone, 2-hydroxy-2-cyclopenten-1-one, hyacinthin, 2, 4-dihydroxy-2, 5-dimethyl-3[2H]-furan-3-one, and phenylethanol, represent aforementioned compounds 5. (Mohamed and Alfarisi, 2017)

**Table 1: Physical characteristics of Tualang honey**

S. No.	Particulars	Amounts
<b>Physiochemical properties</b>		
1.	Appearance	Dark brown
2.	Specific gravity	1.335
3.	pH	3.55- 4.00
4.	Moisture content	23.30%
5.	Total Reducing sugars	67.50%
6.	Fructose	29.60%
7.	Glucose	30.00%
8.	Maltose	7.90%
9.	Sucrose	0.60%
10.	Carbon	41.58%
11.	Oxygen	57.67%
<b>Minerals (mg/100gm)</b>		
12.	Sodium (Na)	1.6 – 1.7
13.	Calcium (Ca)	3 – 31
14.	Potassium (K)	40 – 3500
15.	Magnesium (Mg)	0.7 – 13
16.	Phosphorous (P)	2 – 15
17.	Copper (Cu)	0.02 -0 .6
18.	Iron (Fe)	0.03 – 4
19.	Chromium (Cr)	0.01 – 0.3
20.	Zinc (Zn)	0.05 – 2
21.	Manganese (Mn)	0.02 - 2
<b>Vitamin contents (mg/100gm)</b>		
22.	Thiamine (B1)	0.00 – 0.01
23.	Riboflavin (B2)	0.01 – 0.02
24.	Niacin (B3)	0.10 – 0.20
25.	Pantothenic acid (B5)	0.02 – 0.11
26.	Pyridoxine (B6)	0.01 – 0.32
27.	Folic acid (B9)	0.002 – 0.01
28.	Ascorbic acid (C)	2.2 – 2.5
29.	Phyllochinon (K)	0.025

### Uses of Honey

**Honey as food:** Honey is most commonly consumed in its unpreserved state, i.e. liquid, crystallized or in the comb. In these forms, it is taken as medicine, eaten as food or incorporated as an ingredient in various food recipes (Burgget, 1985; Olaitan *et al.*, 2007). In confectionery production, honey is still included in many traditional products, which are consumed locally in considerable quantities and also exported. In gelatinous or gum product, honey can be used as flavouring agent. In

industrial sector, some honey milk products exist such as pasteurized and homogenized sweetened with honey for long time storage e.g. yoghurt with honey (Ebisu *et al.*, 1988). In the industrial non-alcoholic beverage industry, the use of honey is relatively recent and expanded in 1990. Over 40 new honey drinks were introduced in Japan, of which one was introduced by coca cola bottling company of Tokyo. In many fruit juices, honey is added as flavouring and sweetener. In apple juice, it is also used to classify fruit juice (Spanish dairy corporation, 1975).

**Honey as food preservative and probiotic:** Hydrogen peroxide and non peroxide components such as antioxidants are found to inhibit growth of *Shigella*, *Listeria monocytogenes*, and *Staph. aureus* helping in food preservation. *Clostridium botulinum*, however may be present in small amounts in honey. It has a good potential to be used as a natural source of antioxidants to reduce negative effects of polyphenol oxidase browning in fruit and vegetable processing (Bansal *et al.*, 2005; Chen *et al.*, 2000; Eteraf-Oskouei and Najafi, 2013).

A prebiotic is a non-digestible dietary supplement that modifies the balance of the intestinal microflora stimulating the growth and activity of the beneficial organisms and suppressing potentially deleterious bacteria. Honey is found to be a suitable sweetener in fermented milk products without inhibiting the growth of common bacteria like *Strep. thermophilus*, *Lactobacillus acidophilus*, *Lacto. delbruekii* and *Bifidobacterium bifidum* which are important for maintaining the health of gastrointestinal tract. Honey also increased and supported the growth of *bifidobacterium* (Bansal *et al.*, 2005; Sanz *et al.*, 2005), which is mainly due to the presence of a variety of oligosaccharides (Chow, 2002; Ezz El-Arab *et al.*, 2006; Bansal *et al.*, 2005).

### Home remedies that use honey

- Mix 2 teaspoon of honey with carrot juice and consume regularly. This helps to improve eyesight and is very helpful for those who sit before computer for long hours.
- A mixture of black pepper powder, honey and ginger juice in equal quantities, when consumed thrice daily helps to relieve the symptoms of asthma.

- Regular use of one teaspoon of garlic juice mixed with 2 teaspoon of honey helps to control blood pressure.
- One glass of warm water taken with 2 teaspoon of honey and one teaspoon of lemon juice in the early morning reduces fat and purifies blood.
- Consuming one teaspoon of honey daily help us to lead a healthy life. (Bagde *et al.*, 2013)
- Gargling with honey is very useful in gingivitis.
- A daily addition of honey to the food stimulates digestion and regulates the acidity of the gastric juices.
- One spoon of fresh honey mixed with the juice of half a lemon in a glass of lukewarm water taken first thing in the morning is very effective for constipation, hyperacidity and obesity.
- A mixture of honey and rose petals when taken in the morning, at the initial stages of tuberculosis produces best results.
- It is believed that a moderate quantity of honey and pomegranate (anar) is good for people with heart trouble or heart weaknesses.
- Asafetida (Hing) fried in ghee and mixed with a tablespoon of honey can be taken thrice a day for heavy and painful menstrual periods and leucorrhoea (Kumar *et al.*, 2010).

### Cosmetic uses of bee's honey

Honey and wax of bee are used in the beauty industry as a skin moisturizer, softener and to heal the skin tissue. Some cosmetic applications of bee's honey are given below (Needham, 2008; Bagde *et al.*, 2013)

- Conditioner: 10 ml of olive oil mix with 5ml of bee's honey and apply on hair. Wash after 15 min (Needham, 2008; Bagde *et al.*, 2013)

- Face wash: Small quantity of lemon juice are mix into 5ml of bee's honey and apply on face before washing.
- Facial cleansing scrub: Mix 5g of almond seed powder into 5ml of bee's honey, scrub softly and then wash. (Needham, 2008; Ediriweera and Premarathna, 2018).
- Facial to improve smoothness: A tablespoon of honey mixed with white egg, 1 teaspoon of glycerin and 1/4 cup of flour makes an excellent firming mask. Just apply it on the face, leave for 15 min, and rinse off with warm water.
- Facial to improve softness: Mix one or two tablespoons honey with one-third cup of finely ground oatmeal. Add 1 teaspoon full of rose water. Clean face thoroughly. Apply this mixture uniformly all over the face. Keep for 10 min to 1.5 h. Remove with a soft washcloth and warm water. Rinse with cold water (India MART Inter MESH Limited).
- Facial moisturizing pack: Mix 2 tablespoon honey with 2 teaspoon of whole milk. Apply over the face and keep for 15 min. Rinse off with warm water, and then with cold water.
- Lotion for dry patches of skin: Mix 5ml of bee's honey, 5ml of olive oil and 2.5 ml of lemon juice. Apply on skin and wash after 15 min.

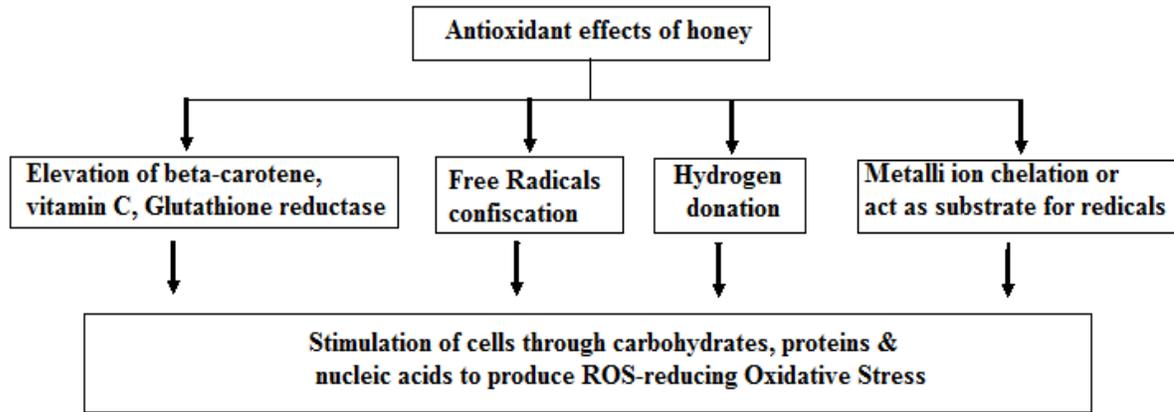
### Religious Significance of Honey

The use of natural honey as food and as medicine by mankind has been in existence a very long time ago. In fact, history reviles that raw honey is the most ancient sweetener, and have been in use throughout the world several million years ago. Honey is widely accepted by all ages, and its use goes beyond the barriers of

ethnicity and culture (Ajibola *et al.*, 2012). The use of honey is embraced by all religious and cultural beliefs. Honey is a nutritional beneficial liquid as written in all holy books, and accepted by all generations, traditions and civilizations, both ancient and modern without any barrier (Ajibola *et al.*, 2012; Nayik *et al.*, 2014).

### Medicinal Effects of Honey and Mechanisms of Action

**Antioxidant Effects of Honey:** Honey exhibits strong antioxidant activity (Ahmed and Othman, 2013). This antioxidant capacity of honey contributes to the prevention of several acute and chronic disorders such as inflammatory, allergic, thrombotic, form of antiradical activity using, oxygen radical absorbance capacity (ORAC) assay, 1,1-diphenyl-2-picrylhydrazyl (DPPH) scavenging assay, and ferric reducing antioxidant power (FRAP) assay (Erejuwa *et al.*, 2012). The phenolic acids and flavonoids are responsible for the well-established antioxidant activity of honey. Apart from these, sugars, proteins, amino acids, carotenes, organic acids, Maillard reaction products, production of reactive oxygen species (ROS), and other minor components also contribute to antioxidant effect (Nagai *et al.*, 2001; Aljadi and Kamaruddin, 2004). Honey (1.2 g/kg) elevated the amount and activity of antioxidant agents such as beta-carotene, vitamin C, glutathione reductase, and uric acid in healthy human subjects (Al-Waili, 2003). The exact antioxidant mechanism is unknown, but the proposed mechanisms include free radical sequestration, hydrogen donation, metallic ion chelation, flavonoids substrate action for hydroxyl, and superoxide radical actions (Al-Mamary, 2002; Van Acker *et al.*, 1996; Ahmed *et al.*, 2018).



**Fig. 1: Mechanism of antioxidant effects of honey**

### ***Antibacterial Effects of Honey***

Antibacterial effect of honey is attributed to presence of inert antibiotic factors in it. These factors include its acidic pH, osmotic effect of sugars, and production of H<sub>2</sub>O<sub>2</sub> by peroxidase. Some nonperoxidase substances also support antibacterial activity which include flavonoids, phenolic acids, and lysozyme (Bogdanov, 2011). In its mechanism of action, a significant role is played by bee defensin-1 (antimicrobial peptide), methylglyoxal (phytochemical), and hydrogen peroxide production by enzyme glucose oxidase (Mandal and Mandal, 2011). Furthermore, high sugar contents of honey can also be helpful in eliminating bacteria through osmosis (Koenig and Roh, 2016). Methylglyoxal (MGO) in honey and its precursor dihydroxyacetone (DHA) have been recognized as inhibitors of bacterial growth through urease inhibition. Urease enzyme facilitates bacteria to acclimate and grow rapidly by producing ammonia in acidic environment (Rückriemen *et al.*, 2017). A very recent study reveals that honey combats bacterial infections by two different mechanisms: inhibition of bacterial quorum sensing (QS) system to retard the expression of *las*, *MvfR*, and *rhl* regulons, as well as its associated virulence factors, and

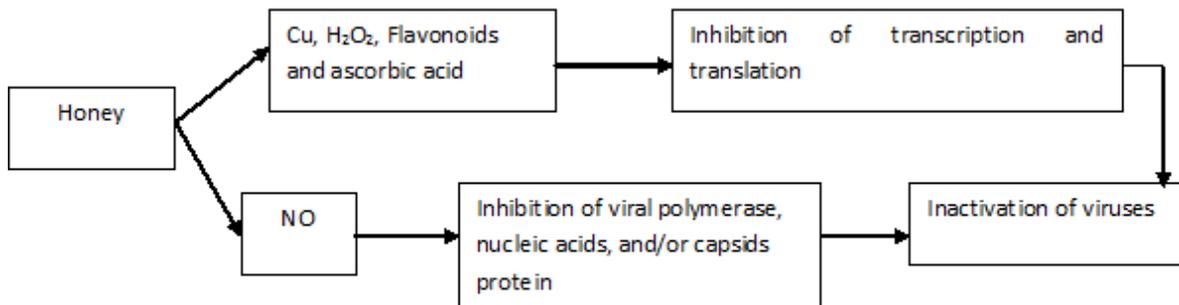
bactericidal components which actively kill bacterial cells (Wang *et al.*, 2012).

### ***Antiviral Effects of Honey***

The viral activity is usually elicited by native or universal stimuli which lead to infections and lesions (Whitley *et al.*, 1998). Current studies have manifested that honey holds potential antiviral effects. Antiviral effect of honey is attributed to its various ingredients which have been found to be operative in controlling of lesions, for instance, copper inactivates virus that is a trace element part of honey. Similarly, presence of ascorbic acid, flavonoids, and H<sub>2</sub>O<sub>2</sub> production by honey also leads to viral growth inhibition by interrupting viral transcription and translation (Kwakman *et al.*, 2011; Vynograd *et al.*, 2000). Data of in vitro studies has shown antiviral activity of honey against different types of viruses such as Rubella, herpes simplex, and varicella zoster viruses (Shahzad and Cohrs, 2012; Zeina *et al.*, 1996, Al-Waili, 2004). Honey comprises secretion from the salivary and pharyngeal glands of the honeybee's head. Recently, nitric oxide (NO) metabolites, nitrite, and nitrate have been identified in salivary gland's section (Al-Waili, 2003). It is well established that NO is an energetic molecule that produces host defense

against viruses, both DNA and RNA viruses. NO acts by slowing down the development of viral lesions as well as arresting their replication (Al-Waili, 2003; Al-Waili and Boni, 2003). In

its mode of action, NO represses replication by interfering with viral polymerase, nucleic acid, and/or viral capsid proteins.

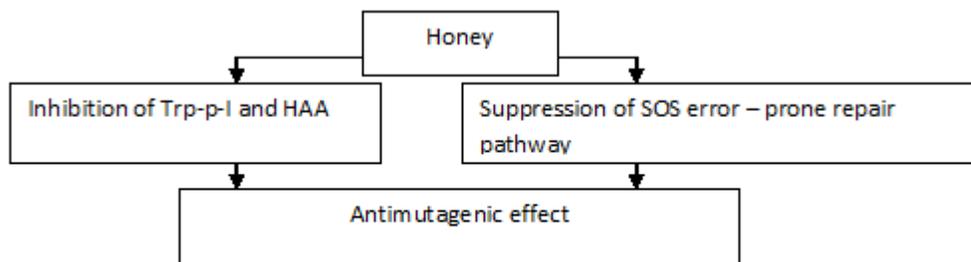


**Fig. 2: Mechanism of antiviral effects of honey**

### Antimutagenic Effects of Honey

Mutagenicity, the ability to induce genetic mutation, is interlinked with carcinogenicity (Rao *et al.*, 1992) Honey exhibits strong antimutagenic activity (Saxena *et al.*, 2012). The effect of honey on radiation (UV or  $\gamma$ )-exposed *Escherichia coli* cells was investigated to observe SOS response, which is an error-prone repair pathway contributing to mutagenicity (Shin and Ustunol, 2004). Some important genes such as *umuC*, *recA*, and *umuD* involved in SOS-mediated mutagenesis were knocked out to elaborate the results. Honey reduced mutation frequency significantly in treatment groups than in

controls. The suppression of error-prone mutagenic repair pathways (for instance SOS response in *E. coli*) was the possible mechanism contributing to the antimutagenic effect. The antimutagenic activity of honey from seven different floral sources (acacia, buckwheat, fireweed, soybean, tupelo, and Christmas berry) and honey sugar analogue against Trp-p-1 was tested by the Ames assay (Wang *et al.*, 2002). All honeys showed a significant inhibition of mutagenicity caused by Trp-p-1. About 30% honey in the infusion formulation was most effective in inhibiting HAA (heterocyclic aromatic amines) formation and overall mutagenicity beef steak and chicken breast (Shin and Ustunol, 2004).



**Fig. 3: Mechanism of antimutagenic effects of honey**

## Medicinal Uses

For centuries honey had been known as nature's medicine. Ongoing medical research is turning up a multitude of curative uses for honey. Medicinal benefits and uses of honey is used as a natural remedy. Honey is not only for eating, but has several different medicinal uses:

- **Arthritis:** Take one part honey to two parts of luke warm water and add a small teaspoon of cinnamon powder, make a paste and massage it on the itching part of the body. It is noticed that the pain recedes within a minute or two. Or for arthritis patients daily morning and night take one cup of hot water with two spoons of honey and one small teaspoon of cinnamon powder. If drunk regularly even chronic arthritis can be cured.
- **Hair loss:** Those suffering from hair loss or baldness may apply a paste of hot olive oil, one tablespoon or honey, one teaspoon cinnamon powder before bath and keep it for approx. 15 min. And then wash the hair. It was found very effective even if kept for 5 min.
- **Toothache:** Make a paste of one teaspoon of cinnamon powder and five teaspoons of honey and apply on the aching tooth. This may be done 3 times a day daily till such time that the tooth has stopped aching.
- **Cholesterol:** Two tablespoons of honey and three teaspoons of cinnamon powder mixed in 16 ounces of tea water if given to a cholesterol patient; it reduces the level of cholesterol in the body by 10% within 2 hours. As mentioned for arthritic patients, if taken 3 times a day any chronic cholesterol cured.
- **Colds:** Those suffering from common or severe colds should take one tablespoon Luke warm honey with 1/4 teaspoon cinnamon powder daily for 3 days. This process will cure most chronic cough, cold and clear the sinuses.
- **Heart diseases:** Make a paste of honey and cinnamon powder, apply on bread or chapatti instead of jelly and jam and eat it regularly for breakfast. It reduces the cholesterol in the arteries and saves the patient from heart attack. Also those who have already had an attack, if they do this process daily, are kept miles away from the next attack, regular use of the above process relieves loss of breath and strengthens the heart beat.
- **Immune system:** Daily use of honey and cinnamon powder strengthens the immune system and protects the body from bacterial and viral attacks. Scientists have found that honey has various vitamins and iron in large amounts. Constants use of honey strengthens the white blood corpuscles to fight bacterial and viral diseases.
- **Indigestion:** cinnamon powder sprinkled on two tablespoons of honey taken before food, relieves acidity and digests the heaviest of meals.
- **Weight loss:** Daily in the morning 1/2 hour before breakfast on an empty stomach and at night before sleeping, drink honey and cinnamon powder boiled in one cup water. If taken regularly it reduces the weight of even the most obese person. Also drinking of this mixture regularly does not allow the fat to accumulate in the body even though the person may eat a high calorie diet.
- **Cancer:** Recent research in Japan and Australia has revealed that advanced cancer of the stomach and bones have been cured successfully. Patients suffering from these kinds of cancer should daily take one tablespoon of honey with one teaspoon of cinnamon powder for one month 3 times a day (Kumar *et al.*, 2010).

## Products Incorporated with Honey

### *Aonla* preserve with incorporation of Honey

The mature *aonla* of medium size were selected from the lot procured. Then, the stems were trimmed and the damaged *aonlas* were discarded. Proper washing was done to remove the adhering dirt and then proper puncturing was done on the *aonlas* using a pricking tool. Next, the *aonlas* bitterness was removed by submerging in limewater (50 g/l, for each kg of fruit), and taken out after 4 h. Hot water was used to remove the adhering CaO from the *aonlas*. Next, the *aonlas* were steeped in 2% salt solution for one day. Proper washing was done to remove the salt on the next day. Then, blanching of *aonlas* was done for 5 min at a temperature of 5°C below the boiling point of water (Srivastava and Kumar, 1994a; 1994b). The *aonlas* were divided into three parts for honey incorporation (the three parts for incorporation were 0, 7.5 and 15% of honey per kg of *aonla*). The *aonlas* were removed and then spread in layers with equal quantity of sugar (done in three separate large jars) and left for 2–3 days. Moisture migrated from the *aonlas* and formed solution with the sugar in jars (Ahmad and Kumaran, 2015).

### Honey powder

Usage of honey powder in dry mixes for cakes and bread found to improve the sales appeal, as well as flavor, color, aroma, texture, and the keeping quality of the product. (Turkot *et al.*, 1960) Use of dried honey in certain types of candy, such as honey nougats, sponges, and caramels would eliminate the flavor damaging high-temperature cooking that was otherwise necessary to remove water in their preparation. (Turkot *et al.*, 1960) Application of dried honey powder in cosmetics and soap industry has also been reported. (Turkot *et al.*, 1960) The other advantages of the dried honey powder are reduced storage space and ease of handling.

In most of the applications, liquid honey is used as such and like any other viscous liquid

food, honey poses problems in handling. Since honey has high viscosity (1.36 N.s/m<sup>2</sup> at 25°C and 21.5% moisture), (White, 1979) loss in adherence to the containers is appreciable unless special efforts are taken to recover it completely. Honey in the dried form could overcome these problems, and therefore, has good commercial potential in the bakery and confectionary industry. Yoshihide and Hideaki (1993) developed a process in which antioxidants, carriers, partial dispersants, and dispersants were added to the honey and the pH of aqueous feed solution was maintained between 6.5–7.5, and the mixture was finally spray dried at inlet and outlet temperatures in the range of 120–200°C and 70–120°C, respectively. The pH of the feed was adjusted to reduce the thermoplasticity of sugary material while drying. Honey content was about 50%, in terms of solids in the dried honey powder. The honey powder obtained was not hygroscopic and possessed good flavor and pleasant taste, besides longer shelf life. However, the low solid content (25%) in the feed material would necessitate higher energy for drying. A process has been described for spray drying of honey in which waxy starch (1.2 to 1.4 times) was added to honey and the mixture was diluted with water up to 20–25% w/w and then spray dried at an inlet temperature of 140–150°C and an exhaust temperature of 90–95°C. (Takashi, 1984). The dried honey powder had a tendency for deliquescence when exposed to air, and hence the need for packaging in laminated aluminum foil has been indicated. The honey content in the final product was reported to be less than 50%.

Takashi *et al.*, (1988) proposed the use of maltitol powder on which concentrated honey was smeared. The concentration of honey was carried out in a decompression dryer below 60°C. The solid honey was smeared with porous powdery maltitol in an atmosphere having a relative humidity less than 45%. Although the honey content in the final powder was relatively higher (68–75%), the process is tedious that requires mixing at low relative humidity besides concentration of honey. Owing to the limitations of the above approaches, spray drying of honey

still remains as the prospective method for the production of honey powder.

### Limitations of Honey

Honey should be evaluated for its toxicological effects based on plants and or nectar source. Though not all, but intoxication by honey may be expected, for instance, mad honey is contaminated with grayanotoxin. Grayanotoxin is found in rhododendron plants in countries such as China, Tibet, Turkey, Nepal, Myanmar, Japan, New Guinea, Philippines, Indonesia, and North America. Mad honey collected in spring is more toxic containing more grayanotoxin (Gami and Dhakal, 2017; Ahmed *et al.*, 2018). Grayanotoxin causes intoxication which may include weakness, dizziness, excessive perspiration, hypersalivation, nausea, vomiting, and paresthesias. It may even lead to life-threatening cardiac complications such as complete atrioventricular block (Gami and Dhakal, 2017).

Honey may become contaminated with germs from plants, bees, and dust during production, collection, and/or processing. Fortunately, antimicrobial activity of honey ensures that most contaminating germs cannot survive or reproduce. However, bacteria that can reproduce using spores, including those that cause botulism, may survive. This is the reason that botulism has been reported in infants given honey orally. To solve this issue, honey or medical-grade honey should be irradiated to inactivate the bacterial spores (N.M.C.D.C. Version, 2009). Sometimes, food allergy due to honey is frequently accompanying with pollen allergy due to the presence of pollens during its collection. Thus, honey may have the possibility of sensitivity in any patient with suspected but unresolved food allergy (Helbling *et al.*, 1992). A typical consumption of sugar and high fructose corn syrup (HFCS) totals the nearly ¾ pound per day for every individual above age 2. However, an amount, which simply

overwhelms, results in elevated blood sugar levels, excessive insulin release, and resultant fat production and storage in the liver (Honey, 2015).

### Conclusion

Honey is highly nutritional with promising properties of anti-oxidant, anti-inflammatory, anti-bacterial agent as well as cough reducing and wound healing characteristics. Honey cakes, honey cookies and biscuits made with honey have pleasant flavour and are much more nutritious than many of sugar based products. Honey consists at least 200 substances mainly carbohydrates and water. It also contains minerals, proteins, free amino acids, enzymes, vitamins, organic acids, flavonoids, phenolic acids, and other phytochemicals. In addition, honey is valuable for the treatment of cardiovascular diseases, cancer, cataract, and several inflammatory diseases as well as wound healing.

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