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**Review** **Open Access**

# Diversity, distribution and medicinal importance of Honeybees in the World-A review

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## ABSTRACT

Honeybees are flying insects, belong to genus *Apis,* are highly social, produce honey and construct colonial nests by wax secreted with the help of workers in the colony. Bees comprise almost 20,000 species, out of which, only ten species are of honeybees, while 29 subspecies of *Apis mellifera* have been reported from all over the world. Honey is composed of sugars (75%), disaccharides (10–15%), water, proteins 0.1% to 3.3%, Amino acids 1% and also having vitamins, minerals, organic acids, phenolic compounds, pigments, more than 400 solid particles and volatile compounds. It is better product than cane-sugar. It is reported that insulin levels don't boost as compared to blood sugar level after intake of honey as compared to other synthetic sugar products of the same caloric value shortly after eating. Few studies have reported that honey minimized impacts of diabetes in living. In traditional medicine, honey is used a remedy of eye disease, expectorant, cold, myalgia, gastritis, snake-bite, teething in child, migraine, stomach, spleen, dark spots, skin, diarrhea, allergy, burn, wounds in the mouth, influenza, toothache, diabetes mellitus, hypertension, atherosclerosis, cancer, urinary system, Alzheimer's disease, throat pain, cough, tonsils, asthma, acidity and obesity. Honey is also used in nanomedicine to treat various diseases and acts as i.e. anti-apoptosis, anti-proliferative, antidiabetic, antioxidant, anti-inflammatory, anti-cataract, antibiotic, antifungal in cornea, reduces the risk of endophthalmitis, regulate blood pressure, antibacterial, antioxidant, and intervention of oxidative stress. It is concluded that honey possesses different types of vitamins, minerals and compounds, which are essential for human health and a therapeutic agent in both traditional and modern medicine.

**Keywords:** Honey, antidiabetic, traditional uses, nanomedicine, diseases

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## INTRODUCTION

Honeybees are flying insects, belong to genus *Apis.* They produce honey and construct colonial nests by secreting wax (Engel, 1999). Honeybees show

complete metamorphosis (Blüthgen and Klein, 2011) and display social behavior (Michener, 1974).

DIVERSITY AND DISTRIBUTION OF HONEYBEES

Bees having almost 20,000 species (Gupta, 2014), out of total only ten are honey bees reported from the whole world i.e. *Apis mellifera* (reported from South America, North America, Europe, Asia, Africa and Australia), *Apis cerana* (Pakistan, India, Myanmar, Thailand, China, Philippines, New Guinea, Malasia, Australia, Indonesia and Korea), *Apis koschevnikovi* (Malaysian, Indonesian, Borneo Malaysia, Malay Peninsula, Sabah, Sumatra and Java), *Apis nulensis* (Borneo), *Apis dorsata* (India, Pakistan, Indonesia, Sri Lanka, Philippines, Borneo and Thailand), *Apis laboriosa* (Western Chinese province of Yunnan, Bhutan, India, Nepal), *Apis binghami* (Indonesian and Thailand), *Apis nigrocincta* (Philippine, China and Indonesian), *Apis florea* (Oman, Iran, China, Myanmar, Pakistan, Sri Lanka, Indonesia, Persian Gulf, Vietnam, Thailand, Malaysia, Philippines, Cambodia, and Nepal) and *Apis andreniformis* (India, Burma, China, Laos, Malaysia, Vietnam, Indonesia, and Philippines) (Table 1). 29 subspecies of *Apis mellifera* have been reported from the whole world (Engel, 1999; Sheppard and Meixner, 2003).

**Table 1: Diversity and distribution of Honeybees in the World.**

| Sr. | Honeybees Species | Distribution | References |
|---|---|---|---|
| 1 | *Apis mellifera* (Linnaeus, 1758) | South America, North America, Europe, Asia, Africa and Australia. | (Winston *et al.*, 1981; Whitfield *et al.*, 2006; Han *et al.*, 2012; Mortensen *et al.*, 2013; Khan *et al.*, 2014; GBIF, 2017) |
| 2 | *Apis cerana* (Fabricius, 1793) | Pakistan, India, Myanmar, Thailand, China, Philippines, New Guinea, Malasia, Australia, Indonesia and Korea. | (Koeniger, 1976; Radloff *et al.*, 2010; Koetz, 2013; Gupta, 2014; Khan *et al.*, 2014) |
| 3 | *Apis koschevnikovi* (Enderlein, 1906) | Malaysian, Indonesian, Borneo Malaysia, Malay Peninsula, Sabah, Sumatra and Java. | (Tingek, 1996; Hadisoesilo *et al.*, 2008; Radloff *et al.*, 2011; Gupta, 2014) |
| 4 | *Apis nulensis* (Tingek, 1996) | Borneo. | (Arias *et al.*, 1996; Tingek, 1996) |
| 5 | *Apis dorsata* (Fabricius, 1793) | India, Pakistan, Indonesia, Sri Lanka, Philippines, Borneo and Thailand. | (Paar *et al.*, 2004; Roubik *et al.*, 2005; Gupta, 2014; Khan *et al.*, 2014) |
| 6 | *Apis laboriosa* (Smith, 1871) | Western Chinese province of Yunnan, Bhutan, Nepal, India. | (Summers, 1990; Batra, 1995; Ahmad F, 2000) |
| 7 | *Apis binghami* (Cockerell 1906) | Indonesian and Thailand. | (Maa, 1953) |
| 8 | *Apis nigrocincta* (Smith, 1861) | Philippine, China and Indonesian. | (Hadisoesilo, 1997; Radloff *et al.*, 2011; Gupta, 2014) |

| | | | |
|---|---|---|---|
| 9 | *Apis florea* (Fabricius, 1787) | Oman, Iran, China, Myanmar, Pakistan, Sri Lanka, Indonesia, Persian Gulf, Vietnam, Thailand, Malaysia, Philippines, Cambodia, and Nepal. | (Deowanish *et al.*, 2001; Hepburn *et al.*, 2005; Gupta, 2014; Khan *et al.*, 2014) |
| 10 | *Apis andreniformis* (Smith, 1858) | India, Burma, China, Laos, Malaysia, Vietnam, Indonesia, and Philippines. | (Rattanawannee *et al.*, 2007; Hepburn and Radloff, 2011; Gupta, 2014) |

## HONEY IMPORTANCE IN RELIGION

Honey is used in various beverages and food as a flavoring and sweetener.

Honey also has a basic role in symbolism and religion. The therapeutic significance of honey has been reported in the world's oldest therapeutic literatures. It has been known to possess wound healing and antimicrobial property since ancient times. In religious Islamic book "Quran", it is also documented that honey is food of Paradise and source of healing, almost 1,400 years ago (Purbafrani *et al.*, 2014; Channa *et al.*, 2018).

## ECONOMIC IMPORTANCE OF HONEYBEES

Honeybee is important due to beneficial activities they perform and the products they produce. Honeybees pollinate agricultural crops i.e. apples, almonds cherries, melons, etc. Honeybees produce wax, which is used for candles and polishes. Honey is used in the cosmetic industry (i.e. skin softener and moisturizer). Honey is also utilized in creams, soaps, shampoos and lipsticks. It is the most utilized product both as medicine and food (Khan, 2015).

## CHEMICAL COMPOSITION OF HONEY

Honey consist of "sugars" (75%), "disaccharides" (10–15%) (Kamal and Klein, 2011), "water", "proteins" 0.1% to 3.3% (i.e. "a- and b-amylases", "a-and b-glucosidase", "d-gluconolactone", "catalase", "acid phosphatase", "diastase", and "glucose oxidase") (Moreira *et al.*, 2007; Won *et al.*, 2009; Sak-Bosnar and Sakač, 2012), Amino acids 1% (consist of lysine, aminobutyric acid, proline and arginine) (Hermosín *et al.*, 2003; Iglesias *et al.*, 2006), organic acids, vitamins ("thiamine" also known as "B1", "riboflavin" i.e. "B2", "nicotinic acid" i.e. "B3", "pantothenic acid" i.e. "B5", pyridoxine i.e. "B6", "biotin" i.e. "B8", "folic acid" i.e. "B9" and "Vitamin C") (Bonté and Desmoulière, 2013), minerals (arsenic, barium, chromium, cobalt, cadmium, calcium, copper, iodine, iron, lithium, magnesium, phosphorus, selenium, silver, manganese, nickel, potassium, sodium and zinc) (Alqarni *et al.*, 2014), pigments, phenolic compounds i.e. anthocyanidin, phenolic acid, flavones, flavanones, flavonols, flavanols, isoflavones and chalcones (Andersen and Markham, 2005), more than 400 volatile compounds (Castro-Vázquez *et al.*, 2007) and solid particles (da Silva *et al.*, 2016).

ETHNOMEDICINAL USES OF HONEY

It is documented that honey is beneficial for diabetics (Table 2). Because it has high sugar contents, so need more research about either it is beneficial or not against diabetic disease; and it is also noted that it is much better than cane-sugar. Some research showed positive results honey minimized the sugar level in blood as compared with non user of honey (Katsilambros *et al.*, 1988). Similarly scientist (Akhtar and Khan, 1989) noted that honey minimized the impacts of the diabetes.

**Table 2: Ethnomedicinal uses of honey.**

| Recipes | Diseases | References |
|---|---|---|
| Spider web ash and honey | Aphrodisiac. | (Dixit *et al.*, 2010) |
| Honey | Eye disease, expectorant, cold, body ache, gastritis, snakebite, erupting of teeth in child, Migrain, stomach, spleen, dark spots, skin, diarrhea, allergy, burn, wounds in mouth, influenza, toothache, diabetes mellitus, hypertension, athero-sclerosis, cancer and Alzheimer's disease. | (Lev, 2003; Mahawar and Jaroli, 2006; Padmanabhan and Sujana, 2008; Jaroli *et al.*, 2010; Oliveira *et al.*, 2010; Benitez, 2011; Lohani, 2011; Yirga *et al.*, 2011; Barros *et al.*, 2012; Erejuwa *et al.*, 2012; Haileselasie, 2012; Betlloch Mas *et al.*, 2014; Mootoosamy and Mahomoodally, 2014; Vijayakumar *et al.*, 2015; Waykar and Alqadhi, 2016; Yeshi *et al.*, 2017) |
| *Cymbopogon citratus* Rhizome, milk and honey | Stomach ache and joint pain. | (Sreekeesoon and Mahomoodally, 2014) |
| Honey and fish otoliths | Urinary system | (Deb and Haque, 2011) |
| Honey and ginger | Throat pain | (Chinlampianga *et al.*, 2013) |
| *Achyranthes aspera* and honey | Cough and asthma | (Abbasi *et al.*, 2011) |
| Honey and cinnamon | Cold, cough, acidity and obesity | (Altaf *et al.*, 2018) |
| Ash of salted heads fish and honey | Tonsils | (Vallejo and González, 2014) |

MODERN MEDICINAL USES OF HONEY

Honey is a substance used for medicine since ancient times. It has “phenolic acids” and “flavonoids” play a basic role in good health of human. Honey has ability to treat anticancer and antimicrobial activity against various kinds of cancers. Further, an antidiabetic activity has also been reported, with the decline of “fructosamine”, “glucose” and “glycosylated hemoglobin” (HbAIc) concentration. It also plays a protective impact in the gastrointestinal system and the cardiovascular system (Table 3).

HONEY USED AGAINST CANCER

Honey has used against cancer. It has anti-proliferative and pro-apoptotic properties, it has anti-cancer properties due to phenolic compounds e.g. "chrysin", which is concerned in the enhanced expression of "caspase-3", "caspase-9" and "pro-apoptotic protein". TNF-α has been involved in honey-induced apoptosis through the introduction of "caspase-8", which is activated by its "chrysin". "TNF-α" and "IL-6" are implicated in immune protective and modulatory properties of the honey. Similarly the estrogen antagonistic impact of honey gives to its immune-modulatory activity (Oršolić, 2009; Li *et al.*, 2010; Mandal and Mandal, 2011; Vallianou *et al.*, 2014).

HONEY USED AGAINST DIABETES MELLITUS

Diabetes is a disorder in metabolic system. Two types of diabetes are among humans: "type 1 diabetes" that found when immune system destroys own body beta cells of Pancreas, and "type 2 diabetes", that may be caused by many factors, the most significant being lifestyle, however may also be displaying by various genes. Honey was utilized in traditional medicine for a long time, but the benefits of health were described in the end of twentieth century when the scientific world was noted the honey benefits. Various studies noted the hypoglycemic impact of honey, but the method of this impact remains unclear (Omotayo *et al.*, 2010; Erejuwa, 2014; Bobiş *et al.*, 2018).

HONEY USED AGAINST EYE DISEASES

Honey is used to treat injured corneas and faster results were noted and also noted that minimized the expression of TGF- β (known as, transforming growth factor beta), vascular EGF (i.e. endothelial growth factor), interleukin-12, interferon-γ, and TNF-α (i.e. tumor necrosis factor alpha) in injured corneas. Further, honey minimized the infection in endotoxin-induced keratitis by lowering the levels of inflammatory cytokines, chemokines and angiogenic factors. It is document that honey minimize infection in vernal cornea and conjunctiva, a seasonal disease documented as an inflammation ailment (Salehi *et al.*, 2014). Honey has "polyphenols" including "phenolic acids" and "flavonoids" are found in the honey as metabolites been documented for their possible utilize as antibacterial compound (Estevinho *et al.*, 2008; Silici *et al.*, 2010). It is documented that flavonoids may help to two major features of the processes concerned in eye health and vision physiology. Flavonoids may also function as antioxidants, and is mainly essential for eye (Rhone and Basu, 2008).

HONEY USED AGAINST HEART DISEASES

Honey is sweetener, provides energy and also used against different diseases in whole world. It is documented that honey has ability to control diastolic as well as systolic BP (i.e. blood pressure) and heart rate (Aluko *et al.*, 2014). Further, it controls BMI and serum homocysteine, C-reactive protein, lipids, and insulin. Normal chemical activities of the nitric oxide, prostaglandins and vasoactive factors are important to maintain heart and blood vessels (Al-Waili *et al.*, 2013).

HONEY USED AGAINST KIDNEY DISEASES

Honey has acquired very much attention due to its wide range antibacterial properties based on wide experimental information. Further, honey has an extra benefit as it shows to avoid inducing antimicrobial resistance in bacteria (Francis *et al.*, 2015). It is documented that carob honey phenolic compounds and contains flavonoid as well as have a powerful antioxidant activity in "2,2'-azino-bis" (i.e. ABTS), "2,2-diphenyl-1-picrylhydrazyl" (i.e. DPPH), and "ferric" (El-haskoury *et al.*, 2018).

HONEY USED AGAINST LIVER DISEASES

It is documented that honey can used to treat hepatic damage. Polyphenols might be bioactive compound and has antioxidant features (Zhao *et al.*, 2018).

Table 3: Honey used in modern medicines.

| **Treatment** | **Impacts** | **References** |
|---|---|---|
| **Cancer** | Apoptosis and anti-proliferative | (Oršolić, 2009; Li *et al.*, 2010; Mandal and Mandal, 2011; Vallianou *et al.*, 2014) |
| **Diabetes mellitus** | Antidiabetic and antioxidant. | (Omotayo *et al.*, 2010; Erejuwa, 2014; Bobiş *et al.*, 2018) |
| **Eye diseases** | Anti-inflammatory, anticataract, antioxidants, antibiotics, antifungalin cornea and reduces the risk of endophthalmitis. | (Rhone and Basu, 2008; Vit and Jacob, 2008; Cernak *et al.*, 2012; Salehi *et al.*, 2014) |
| **Heart diseases** | Regulate blood pressure and heart rate. | (Al-Waili *et al.*, 2013; Aluko *et al.*, 2014) |
| **Kidney diseases** | Antibacterial and antioxidant. | (Francis *et al.*, 2015; El-haskoury *et al.*, 2018) |
| **Liver diseases** | Antioxidant and intervention of oxidative stress. | (Zhao *et al.*, 2018) |

CONCLUSION

It is concluded that honey has different types of vitamins, minerals, and compounds, which are essential for human. Honey is also important to treat various diseases in tradition as well as modern uses.

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