



## Physical, Chemical and Antioxidant Properties of Honey: A Review

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### Abstract

Honey is the organic, natural sugar, produced from the nectar and exudation of plant by honey bees, *Apis mellifera*. Honey has powerful immune system booster. Its antioxidant and antibacterial properties help to improve digestive system. Other than carbohydrates, honey contains proteins, enzymes, amino acids, minerals, trace elements, vitamin and other photo-chemical. Different types of honey have different compositions of biochemical and biophysical properties. Different types of antioxidants such as phenolic acids and flavonoids, certain enzymes (glucose oxidase and catalase) are present in honey. So, honey is beneficial to serve as a natural food antioxidant.

**Keywords:** Honey, *Apismellifera*, glucose oxidase, flavonoids

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## 1. Introduction

Honey is the organic, natural sugar, produced from the nectar and exudation of plant by honey bees, *Apis mellifera*. It is used as traditional food since the date back to 2100 B.C.<sup>1,6,28</sup>. Honey bees transforms nectar of flowers into honey by the process of regurgitation and evaporation. The sweetness of honey comes from the monosaccharide (fructose and glucose). The carbohydrates of honey provide strength and energy to our body<sup>3</sup>. Honey has important effect in instantly boosting endurance and it reduces muscle fatigue of the body. The glucose in honey gives immediate energy to body boost, where as the fructose is absorbed slowly by the body providing sustained energy. Honey has powerful immune system booster.<sup>2</sup> Its antioxidant and antibacterial properties help to improve digestive system.<sup>6,7,14,16</sup> Other than carbohydrates, honey contains proteins, enzymes, amino acids, minerals, trace elements, vitamin and other photo-chemical. Different types of honey have different compositions of biochemical and biophysical properties.

Different types of antioxidants such as phenolic acids and flavonoids, certain enzymes (glucose oxidase and catalase) are present in honey.<sup>6-10</sup> Now these days the evidence of the antioxidant capacity of honey has been proved that honey can prevent deteriorative oxidation reaction in foods, such as lipid oxidation in meat and enzymatic browning of fruits and vegetables. So, honey is beneficial to serve as a natural food antioxidant. In the previous

studies it was examined that honey is similar in antioxidant capacity to many fruits and vegetables on a fresh weight basis, which is measured by the Oxygen Radical Absorbance Capacity (ORAC) assay<sup>17,18</sup>. However, the antioxidant properties of honey, varies depending upon the floral sources.<sup>5</sup> There is a lack of knowledge about these antioxidant properties of honey. Several studies on Indian honey have been shown that honey has a high phenolic profile consisting of benzoic acids and their esters, and flavonoid aglycans.<sup>5-7</sup>

Honey is a traditional treatment for infected wounds as long as 2000 years ago when bacteria were discovered and also it can be effective on antibiotic resistant strains of bacteria.<sup>10</sup> The antibacterial properties vary depending upon the region from where it has generally collected. Honey is selected for clinical testing which should be evaluated on the basis of antibacterial activity levels determined by laboratory testing. Hydrogen peroxide, which is known as antimicrobial agent, is produced in honey solution commonly used as antiseptic. The harmful effects of hydrogen peroxide are further reduced because honey inactivates the free ions which catalyses the formation of oxygen free radicals. Now these days, scientists are reporting that the antibacterial properties of honey are very useful for the treatment of wound healing. Different types of wound infections including burns, venous leg ulcers, leg ulcers of mixed etiology, diabetic foot ulcers, pressure ulcers, unhealed graft donor sites, abscesses, boils, pilonidal sinuses, infected wounds from lower limb surgery, necrotizing fasciitis and neonatal postoperative wound infections are treated by honey.

## 2. Honey an ancient medicine

Honey, a well known natural healing agent with antibacterial and antioxidant property was used by ancient Greek people for thousands of years to treat wound. Honey is a traditional treatment for infected wounds as long as 2000 years ago when bacteria were discovered and also it can be effective on antibiotic resistant strains of bacteria. It is used as traditional food since the date back to 2100 B.C. Honey is the organic, natural sugar, produced from the nectar and exudation of plant by honey bees, *Apis mellifera*. Honey bees transform nectar of flowers into honey by the process of regurgitation and evaporation.<sup>1,6,28</sup>

### Physical and chemical composition of honey

Honey is basically acidic in nature. The pH and acidity level changes depending upon the botanical origin mainly geographic origin of honeys the level of pH stands in between 2-6.<sup>4,13</sup> Honey contains minerals and acids serving as electrolytes, which can conduct the electrical current. The measurement of electrical conductivity (EC) was introduced in 1964. The average conductivity of Nigerian honey is between 9.419-172.900  $\mu\text{S cm}^{-1}$ . Moisture content of honey depends upon harvest season, along with the degree of maturity reached in the live. Honey has water content between 15-18 %.<sup>4</sup> Color in liquid honey varies from clear and colorless (like water) to dark amber or black. The color of honey is amber or gold. The range of color of honey is in between 52.00-255.00<sup>1</sup>.

The average range of ash content of honey varies between 0.095-0.518.<sup>1</sup> The ash content of locally produced honey samples ranged between 0.047-0.35 which is within average standard limits.<sup>3,4</sup> Ash content of honey is about 0.21 % of its weight, but it varies from 0.02-1.0 % (quality and standards authority of Ethiopia, 2005). The natural product honey has been reported to contain about 200 substances, which consist of not only highly concentrated solution of sugars, but also the complex mixture of other saccharides, amino acids, peptides, enzymes, proteins, organic acids, polyphenols, carotenoid like substances, vitamins, and minerals.<sup>3, 7, 11-13, 31</sup> Sugars are the main constituents of honey, comprising about 95 % of its dry weight.<sup>28</sup> While glucose and fructose are dominant constituents, among 25 different sugars have been detected.<sup>15</sup> According to White (1975), protein present in honey is mainly enzymes. Honey contains roughly 0.5 % proteins and the protein contents in some honeys can be over 1000  $\mu\text{g/g}$ .<sup>28, 11</sup> Main enzymes are diastase, invertase, glucose oxidase and catalase. Although the content of amino acids in honey is relatively small, it has been found that almost all of physiologically essential amino acids are present in honey.<sup>3, 7, 13</sup>

The primary amino acid is proline, contributing 50-85 % of the total amino acids.<sup>12</sup> The level of organic acids in honey is relatively low and about 18 organic acids have been detected. Most of the acidity present in honey is added by honeybees. Gluconic acids, the predominant organic acid, are the product of glucose oxidation, presenting at 50-fold higher levels than other acids. Investigations have shown that a wide range of trace elements are present in honey, including Al, Ba, Bi, Co, Cr, Mo, Ni, Pb, Sn, Ti as well as minerals (Ca, Cu, Fe, K, Na, Mg, Zn),<sup>11</sup> among them, the main mineral element is potassium while copper present lowest amount<sup>12</sup>. Vitamins such as thiamin (B1), riboflavin (B2), pyridoxine (B6), and ascorbic acid (C) have also been reported but their amount is very small in honey.<sup>12</sup> When honey is treated with mild heat or prolonged storage, a compositional change can occur due to caramelization of the carbohydrates, the Maillard reaction, and decomposition of fructose in the acid medium of honey.<sup>11</sup>

### Antioxidant properties of honey

Honey contains a significantly high level of antioxidants, both enzymatic and nonenzymatic, including catalase, phenolic acids, flavonoids, carotenoids, organic acids, ascorbic acids, amino acids and Maillard reaction products. Phenolic compounds commonly found in honey include phenolic acids, flavonoids and polyphenols<sup>5-10, 14, 16-18, 21</sup>.

Honey phenolic acids can be catechic acid, hydroxybenzoic acid, caffeic acid, chlorogenic acid, vanillic acid, p-coumaric acid, benzoic acid, ellagic acid, cinnamic acid, and flavonoids in honey consist of naringenin, kaempferol, apigenin, pinocembrin, chrysin, galangin, luteolin etc<sup>32</sup>. The large and complex flavonoids greatly contribute to honey color, flavor, anti-fungal, and antibacterial activity<sup>22</sup>. The antioxidant capacity of different honeys depends on the floral sources used by bees to collect nectar, seasonal and environmental factors, as well as processing ways.<sup>17,18</sup> Although the total antioxidant activity of honey is the combination of a wide range of active substances, the content of phenolic compounds can significantly reflect the total antioxidant activity of honey to some extent.<sup>5, 6, 8, 9</sup> However, the level of phenolic compounds present in honey is not always positively proportional to its antioxidant activity. The explanation for this activity may be due to the presence of variable types of polyphenols, thereby providing variable scavenging activity. Darker honey is likely to have a higher antioxidant contents than light colored honey. As well, the antioxidant content is higher in honey with higher water content.<sup>11</sup>

### 3. Use for wound healing

A review of honey's use in wound care by Molan (2006) has overwhelming evidence that honey is a credible wound treatment option. With regards to wound treatment by honey application, the osmotic action of honey can induce outflow of lymph, which is able to promote extra oxygenation and provide improved supply of nutrients on the wound surface, as well as to flush away proteases that may inhibit the repair process. Moreover, honey's osmotic action can create a moist environment that is required for the fibroblasts to contract and pull the margins of wound together.<sup>35</sup> The acidic pH of honey also adds the value to aid wound healing since it can facilitate to release the oxygen carried by hemoglobin. It has been noted that acidification of wounds can improve the speed of the healing process. A number of studies have firmly reinforced that honey is an effective medicinal treatment for burns and infected wound and it is more effective as a dressing than many other present alternatives.<sup>34</sup>

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