

An Overview of Honey: Its Composition, Nutritional and Functional Properties

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Abstract: Honey is a natural food/product that can be used for various purposes. High-quality honey can be distinguished by flavor and consistency. The composition, appearance, sensory perception and biological effects of honey depend on the floral source used to collect nectar by honeybee, seasonal and climatic factors. Honey flavor is an important factor for the consumer's choice. About 95% of the honey dry matter is composed of carbohydrates. The main sugars are the monosaccharides fructose and glucose and 5-10% of the total carbohydrates are oligosaccharides. Honey contains proteins, minerals, vitamins, polyphenols, vitamins, enzymes, organic acids and volatiles. The three main honey enzymes are diastase, invertase and glucoseoxidase. The average pH of honey is 3.9, but can range from 3.4 to 6.1. The viscosity of honey is affected by both temperature and water content. The glycemic index of honey varies from 32 to 87. Honey has been shown to possess antioxidant, antimicrobial, antiviral, antiparasitary, anti-inflammatory, antimutagenic and anticancer effects. The low water activity of honey inhibits microbial growth. The antibacterial effect of honey, is mostly against gram-positive bacteria. Honey is a source of natural antioxidants, which are effective in reducing the risk of many diseases. Most of the health promoting properties of honey are only achieved by application of rather high doses of honey such as 50 to 80 g per intake. This information shows that honey has a wide range of positive effects on nutrition and health.

Key words: Honey, composition, nutrition, health, functional properties.

1. Introduction

Honey is a natural substance produced by honeybees (*Apis mellifera*) from the nectar of flowers which is a sweet, flavorful, viscose liquid. It has been used as a food and medical product since the earliest times [1]. It is well known for its nutritional and medicinal qualities resulting from healthy ingredients which are strongly associated with its floral origin [2, 3]. Also, its composition and quality vary depending on production method, climatic conditions of the region, conditions of handling and storage and the nectar, which is the source of honey [4]. This natural product is a concentrated aqueous solution of different carbohydrates such as fructose, glucose, maltose, sucrose, and other oligo- and polysaccharides [5]. Also it contains certain minor constituents including proteins, enzymes, amino and organic acids, lipids,

vitamins, minerals, flavor compounds and flavonoids and phenolic compounds [1, 3]. However, honey constituents can be changed during storage because of different chemical reactions such as fermentation, oxidation and thermal processing [6]. In this review, it is aimed to give summary information about general composition, quality criteria, nutritional and functional properties of honey.

2. Composition of Honey

The composition of honey basically varies to the floral source, but seasonal, environmental factors and processing conditions are also important [1]. Honey is a source of simple carbohydrates of which fructose (38.5%) and glucose (31%) are of total 82.4% carbohydrate. The remaining 12.9% of carbohydrates consists of maltose, sucrose and other sugars [7]. Other sugars are isomaltose, nigerose, turanose, maltulose; kojibiose; alpha beta-trehalose, gentiobiose,

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laminaribiose; maltotriose, 1-kestose, panose, isomaltosyl glucose, erlose, isomaltosyltriose, theanderose, centose, isopanose, isomaltosyltetraose and isomaltosylpentaose. But not all these sugars exist in nectar but forms during ripening or the effect of other factors such as bee enzymes and acids [8]. The protein content of honey changes to the species of the honeybees. For example while protein varies from 0.1% to 3.3% in *Apis cerana*, it varies from 0.2% and 1.6% in *Apis mellifera* [9]. The portion of amino acids in honey is 1%. Although the most abundant amino acid is proline which constitutes 50-85% there are 26 amino acids such as glutamic acid, aspartic acid, glutamine, histidine, glycine, threonine, β -alanine, arginine, α -alanine, aminobutyric acid, proline, tyrosine, valine, methionine, cysteine, isoleucine, leucine, tryptophan, phenylalanine, ornithine, lysine, serine, asparagine and alanine [10]. Enzymes in honey are originated from two sources: invertase, glucose oxidase, and amylase comes from hypopharyngeal glands of worker honeybees. On the other hand, catalase, acid phosphatase and a small proportion of amylase are arisen from plants [8]. The mineral and vitamin content of honey is very low, which constitutes 0.02% of its weight [8]. While potassium constitutes almost one third of the total mineral content of honey, it also contains sodium, iron, copper, silicon, manganese, calcium and magnesium at small quantities [11]. Organic acids which constitute 0.57% of honey give honey acidity. The predominant acid in honey is gluconic acid and citric acid, a good parameter for discrimination floral and honey dew [12]. On the other hand, free acidity which is important for honey deterioration is resulted from some inorganic acids [13]. The major transformations associated with storage are free acidity, lactic acidity, diastase activity and 5-hydroxymethylfurfural (HMF) content [13].

3. Quality Characteristic of Honey

The quality of honey is mainly associated by its sensorial, chemical, physical and microbiological

characteristics. The European Council Directive 2001/110/EC [14] defines honey and establishes minimum quality standards for honey when placed on the market as honey or used as an ingredient in products intended for human consumption. In 2015 the European Commission organised an “EU coordinated control plan” to assess the prevalence on the market of honey adulterated with sugars and honeys mislabelled with regard to their botanical source or geographical origin [15]. The major criteria of characteristics of honey are moisture content, electrical conductivity, ash content, reducing and non-reducing sugars, free acidity, diastase activity and HMF content [16]. For this reason, various countries set strict standards for commercial honey, including specific physical properties and chemical compositions. Thermal treatment which is applied for delaying its crystallisation, and destroying the contaminate microorganisms may destroy vitamins and bionutrients, and produce a simultaneous decrease in diastase activity and an increase in HMF content. For controlling of diastase activity and HMF content, national and international parameters are used to limit thermal treatment application [17].

4. Sensory, Physical and Chemical Properties of Honey

Sensory property such as color and flavor is a major parameter in determining the quality of honey and changes to the several factors such as the geographical, and seasonal conditions and as the floral source [18]. The most changeable feature of honey is color and has great importance as it is an indicator of its origin and quality [19]. The color of honey varies from very pale yellow through amber and dark reddish amber to nearly black [20]. The mass-produced honey, which is a mixture of many honey, can be uniformly colored. The individual harvested honey may have a range of colors depending on the season of the nectar (flower origin), the time between nectar collection and honey harvesting, production details such as heating,

temperature and/or storage time and pollen grains and morphology [21, 22]. On the other hand mineral content has effect on the color and the taste of honeys and the higher content of minerals make the color darker and stronger taste [23]. Another aspect of honey quality is its appearance. It can be fluid, viscous, partly or totally crystallized form and appearance is important for commercial honey, as consumers demand a fluid, non-crystallized product. Although raw honey is in a liquid state, it can contain small or big crystals depending on numerous factors such as origin, temperature, moisture content, and sugar content [24]. The pH of honey ranges from 3.2 to 4.5 [8]. The water activity of honey, which is important on the spoilage of honey, is within a range of 0.5-0.65 [25]. Honey flavor is related with the volatile compounds and they can vary to the seasonal conditions and geographical origin [26]. On the other hand aroma of honey depends also on the quantity and type of acids and amino acids [27]. The another property of honey is viscosity, which is considered one of the most important properties of honey. This property is important especially for beekeepers and honey processors, because the rheological behavior has importance for a longer shelf life and facilitating proper handling, packing, and processing of honey [28].

5. Nutritional, Antimicrobial and Functional Properties of Honey

Honey has a very long history of human consumption as the oldest sweetener and health food. As far back as 5500 BC, honey was mentioned in the writings of Egypt, India, and China [29]. Honey is food consumed worldwide and is increasingly being used as a substitute for granulated sugar. Although honey is the most sweet food its glycemic load is low [30]. Honey has been widely used as food and medicine by all generations, traditions, and civilizations. Honey has been used by humans to treat a variety of ailments through topical application, but it

recently gained importance as of the antiseptic and antimicrobial properties too. Honey has been reported to be effective in a number of human pathologies. Clinical studies have demonstrated that application of honey to severely infected cutaneous wounds rapidly clears infection from the wound and improves tissue healing. Studies showed that honey has a broad-spectrum antimicrobial (antibacterial, antifungal, antiviral, and antimycobacterial) properties of honey. It may be attributed to the acidity (low pH), osmotic effect, high sugar concentration, presence of bacteriostatic and bactericidal factors which are hydrogen peroxide, antioxidants, lysozyme, polyphenols, phenolic acids, flavonoids, methylglyoxal, and bee peptides [29]. Honey is an ingredient for traditional medicine, because of its dietary and curative properties since ancient times [31]. Many studies demonstrated that honey is a source of natural antioxidants which are effective in reducing the risk of heart disease, cancer, immune-system decline, cataracts, different inflammatory processes etc. The components responsible for antioxidative effect of honey are flavonoids, phenolic acids, ascorbic acid, catalase, peroxidase, carotenoids and products of the Maillard reaction [32]. The quantity of these components varies widely according to the floral and geographical origin of honey [20]. Functional properties of honey in human health depend largely on the floral source of the honey and these properties could be related to honey high osmolarity and antibacterial properties [33]. As polyfloral honeys may contain higher levels of flavonoid and phenolic compounds than monofloral ones they have higher antioxidant activity. This for, honey consumption has potential health benefits due to the antioxidant and antimicrobial properties of honey [34]. Honey contains more than 200 components, with fructose, glucose, and water as main substances [35]. The antioxidant activity depends on the floral source, as well as on seasonal and environmental factors and the processing may also

have effect on composition and antioxidant activity of honey [36].

6. Consumption of Honey

Honey, a natural sweet substance, has a wide range of applications in the food industry. It can be consumed directly or be used as an ingredient of various processed foods as it has nutritional value and unique flavor [37]. On the other hand, honey is often enriched with pollen, propolis, royal jelly, or other primary bee products to enhance its taste, nutritional and medicinal properties without changing its composition. Also, honey prepared with nuts such as walnut, almond and hazel-nut and dried fruits is consumed as a tasty dessert [38]. Although honey is used as sweetening agent in foods, it is also used as a food preservative [39]. On the other hand, healthier lemonade is made using instead of sucrose.

7. Conclusions

High-quality honey has a variety of positive nutritional and health effects. The quality of honey depends on its floral origin and chemical composition. Honey has been always taken place in diet not only nutritional aspects but also for health properties. The main nutrition- and health-relevant components are the carbohydrates, which make it an excellent energy source, especially for children and sportsmen. Honey is highly special, nutritious, functional and healthy food. Except nutritious value, it inhibits some food spoilage organisms too. As it has high antioxidant activity it is preferred as not only direct consumption but also supportive or preservative in foods. To make use of the miracles of honey, the tricks of honey should be avoided. Quality honey production and consumption should be increased. Adulteration of honey, decreases income of honest producers and it also has negative effects on consumers' nutrition and health.

Conflict of Interest

The authors have declared no conflict of interest.

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