

**A REVIEW: HONEY FOR NUTRITION AND HEALTH****Miss. Mohini Shrikant Jogdande\* and Dr. Sachin A. Nitave**

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**ABSTRACT**

Due to the variation of botanical origin honey differs in appearance, sensory perception and composition. The main nutritional and health relevant components are carbohydrates, mainly fructose and glucose but also about 25 different oligosaccharides. Although honey is a high carbohydrate food, its glycemic index varies within a wide range from 32 to 85, depending on the botanical source. It contains small amounts of proteins, enzymes, amino acids, minerals, trace elements, vitamins, aroma compounds and polyphenols. The review covers the composition, the nutritional contribution of its components, its physiological and nutritional effects.

**KEYWORDS:** Honey, nutrition, composition, glycemic index.**INTRODUCTION**

Honey has been highly appreciated as an alimentary product and has been largely used since ancient times as well as in cosmetic manufacturing. Honey is a sugary substance obtained from the nectar of the flowers or from the secretions which come from or lie on the living parts of the plant and which honey bees crop, transform and combine with their own specific substances and store in the honeycomb of the beehive.<sup>[1]</sup> Honey is a product extremely rich in sugars of which glucose and fructose are outstanding. It also possesses vitamins, mineral salts and microorganisms in honey have long been used to control the spoilage of honey. Microorganisms in honey may influence quality and safety.

Honey forms part of the traditional medicine in many cultures. The antibacterial properties of honey may be particularly useful against bacteria which have developed resistance to many antibiotics. For example, *Staphylococcus aureus*, which was the major cause of wound sepsis

in hospitals. Honey is thus an ideal topical wound dressing agent in surgical, infections, burns and wound infections. Honey has been extensively used as a healing agent throughout human history in addition to its widespread usage as a popular food. Honey is a sweet substance produced as a food source mainly from the nectar and secretions of plants by honey bees. Honey is used to feed bees during the winter. For centuries, honey has been used as food and as natural medicine, being prescribed by physicians of many ancient cultures for the treatment of a wide variety of ailments. The art of apiculture and the benefits of honey have been known.<sup>[1]</sup> The colour of honey can vary from clear to dark amber according to its floral source and mineral content and it has a close relationship with its flavour and quality. Honeys may be viscous liquids or even solid with differing honeys identifiable by their colour, flavour, crystallization and the presence of pollen grains in honey sediment. Honey is mainly composed of water and sugar (about 96%) with the remainder being substances such as amino acids, enzymes, minerals, flavonoids, phenolic acids, ascorbic acid, carotenoid-like substances, organic acids and several other compounds. D-fructose and D-glucose are the predominant sugars. The antimicrobial agents in honey are predominantly hydrogen peroxide, of which the concentration is determined by relative levels of glucose oxidase, synthesized by the bee and catalase originating from flower pollen. Several components are known to contribute to the non-peroxide activity, such as the presence of methyl syringate and methylglyoxal, which have been extensively studied in Manuka honey that is derived from the Manuka tree. At the same concentration, the Manuka honey retained its antibacterial activity in the presence of catalase (absence of  $H_2O_2$ ). The presence and concentrations of these phytochemicals in honeys can vary depending upon the floral source, geographical and climatic conditions. The antibacterial nature of honey was dependent on various factors working either singularly or synergistically, the most salient of which are  $H_2O_2$ , phenolic compounds, wound pH, pH of honey and osmotic pressure exerted by the honey.<sup>[2]</sup>



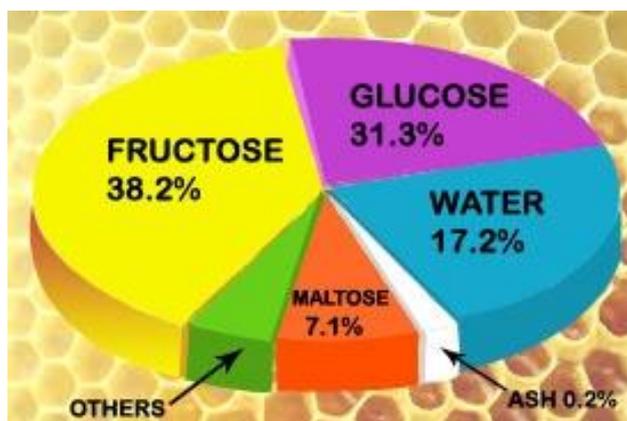
Several authors reported that different honeys vary substantially in the potency of their antibacterial activity, which varies with the plant source. The concentration of honey has an impact on antibacterial activity and the higher the concentration of honey the greater its usefulness as an antibacterial agent Taormina et al reported that the concentration of honey needed for complete inhibition of *Salmonella typhimurium* growth as <25%. Antimicrobial agents are essentially important in reducing the global burden of infectious diseases Natural honey of other sources can vary as much as 100-fold in the potency of their antibacterial activities which is due to hydrogen peroxide In addition, honey is hygroscopic which means that it can draw moisture out of the environment and dehydrate bacteria and its high sugar content and low level pH can also prevent the microbes from growth.<sup>[2]</sup>

### **History of Honey as Medicine**

Honey is a popular sweetener throughout the world. According to an Associated Marketing survey conducted for the National Honey Board in 1997, almost 77 per cent of U.S. households use honey along with other sweeteners and syrups and 45 per cent of them consider honey a good value because it is "natural/good for you/better for you than sugar".<sup>[3]</sup> References to honey as a medicine are found in ancient scrolls, tablets and books Sumerian clay tablets estimated to be 6200 B.C, Egyptian papyri dated from 1900-1250 B.C, Veda (Hindu scripture) about 5000 years old the Holy Koran the Talmud, both the old and new testaments of the Bible, Sacred books of India, China, Persia and Egypt and Hippocrates 460-357 BC.<sup>[4]</sup>

### **COMPOSITION OF HONEY**

The overall composition of honey is shown in figure. The carbohydrates are the main constituents, comprising about 95% of the honey dry weight. Beyond carbohydrates, honey contains numerous compounds such as organic acids, proteins, amino acids, minerals, polyphenols, vitamins and aroma compounds. Summarising the data shown in that the contribution of honey to the recommended daily intake is small. However, its importance with respect to nutrition lies in the manifold physiological effects .It should be noted that the composition of honey depends greatly on the botanical origin a fact that has been seldom considered in the nutritional and physiological studies.<sup>[5,6]</sup>



The composition commonly found in honey.

Composition	Range
Fructose/Glucose ratio	0.76 - 1.86
Fructose %	30.91 - 44.26
Glucose %	22.89 - 40.75
Mineral %	0.020 - 1.028
Moisture %	13.4 - 22.9
Reducing sugar %	61.39 - 83.72
Sucrose %	0.25 - 7.57
Ph	3.42 - 6.10
Total acidity meq/kg	8.68 - 59.49
Protein mg/100g	57.7 - 567
Source: The National Honey Board	

### COLOR OF HONEY

The color of honey can be categorized into seven categories with Pfund color scale of 0 to more than 114 mm, as shown in fig. The color of honey partly reflects the content of pigments with antioxidant properties such as carotenoids and flavonoids. In addition, the color intensity of honey may be considered as a good indication of its antioxidant capacity.<sup>[7]</sup>



### The color classification in honey

Color	Pfund scale (mm)	Optical Density
Water White	< 8	0.0945
Extra White	09 - 17	0.189
White	18 - 34	0.378
Extra Light Amber	35 - 50	0.595
Light Amber	51 - 85	1.389
Amber	86 - 114	3.008
Dark Amber	> 114	-----

### Carbohydrates

The main sugars are the monosaccharides fructose and glucose. Additionally, about 25 different oligosaccharides have been detected. The principle oligosaccharides in blossom honey are the disaccharides sucrose, maltose, trehalose and turanose, as well as some nutritionally relevant ones such as panose, 1-kestose, 6-kestose and palatinose. A daily dose of 20 g honey will cover about 3% of the required daily energy.<sup>[7]</sup>

### Proteins, enzymes and amino acids

Honey contains roughly 0.5% proteins, mainly enzymes and free amino acids. The contribution of that fraction to human protein intake is marginal. The three main honey enzymes are diastase (amylase), decomposing starch or glycogen into smaller sugar units, invertase (sucrase,  $\alpha$ -glucosidase), decomposing sucrose into fructose and glucose, as well as glucose oxidase, producing hydrogen peroxide and gluconic acid from glucose.<sup>[7]</sup>

### Vitamins, minerals and trace compounds

The amount of vitamins and minerals is small and the contribution of honey to the recommended daily intake (RDI) of the different trace substances is marginal. It is known that different unifloral honeys contain varying amounts of minerals and trace elements. The elements sulphur, boron, cobalt, fluoride, iodide, molybdenum and silicon can be important in human nutrition too, although there are no RDI values proposed for these elements.<sup>[8]</sup>

### Aroma compounds, taste-building compounds and polyphenols

There is a wide variety of honeys with different tastes and colours, depending on their botanical origin. The sugars are the main taste-building compounds. Generally, honey with a high fructose content (e.g. acacia) are sweeter compared to those with high glucose concentration (e.g. rape). The honey aroma depends also on the quantity and type of acids and amino acids present. In the past decades extensive research on aroma compounds has

been carried out and more than 500 different volatile compounds were identified in different types of honey. 56 to 500 mg/kg total polyphenols were found in different honey types. Polyphenols in honey are mainly flavonoids (e.g. quercetin, luteolin, kaempferol, apigenin, chrysin, galangin), phenolic acids and phenolic acid derivatives. These are compounds known to have antioxidant properties.<sup>[8]</sup>

### **Contaminants and toxic compounds**

The same as any other natural food, honey can be contaminated by the environment, e.g. by heavy metals, pesticides, antibiotics etc. Generally, the contamination levels found in Europe do not present a health hazard. The main problem in recent years was the contamination by antibiotics, used against the bee brood diseases, but at present this problem seems to be under control. A few plants used by bees are known to produce nectar containing toxic substances. The substances of the other toxin group, the pyrazolidine alkaloids, found in different honey types and the potential intoxication by these substances is reviewed. Cases of honey poisoning have been reported rarely in the literature and have concerned individuals from the following regions: Caucasus, Turkey, New Zealand, Australia, Japan, Nepal, South Africa, and also some countries in North and South America. Observed symptoms of such honey poisoning are vomiting, headache, stomach ache, unconsciousness, delirium, nausea and sight weakness.<sup>[8]</sup> In general the poisonous plants are known to the local beekeepers and honey, which can possibly contain poisonous substances, is not marketed. To minimize risks of honey-borne poisoning in countries where plants with poisonous nectar are growing, tourists are advised to buy honey in shops and not on the road and from individual beekeepers.

### **Glycemic index and fructose**

The impact of carbohydrates on human health is discussed controversially, especially the understanding of how the carbohydrates of a given food affect the blood glucose level. Today, the dietary significance of carbohydrates is often indicated in terms of the glycemic index (GI). Carbohydrates with a low GI induce a small increase of glucose in blood, while those with a high GI induce a high blood glucose level. There was no significant correlation between GI and the other honey sugars. The GI values of 4 honeys found in one study varied between 69 and 74 while in another one the value of a honey of unidentified botanical origin was found to be As the GI concept claims to predict the role of carbohydrates in the development of obesity, low GI honeys might be a valuable alternative to high GI sweeteners.<sup>[9]</sup> The consumption of honey types with a low GI, e.g. acacia honey might have

beneficial physiological effects and could be used by diabetes patients. An intake of 50 g honey of unspecified type by healthy people and diabetes patients led to smaller increases of blood insulin and glucose than the consumption of the same amounts of glucose or of a sugar mixture resembling to honey. It was shown that consumption of honey has a favorable effect on diabetes patients, causing a significant decrease of plasma glucose. Honey was well tolerated by patients with diabetes of unspecified type and by diabetes type-2 patients. According to recent studies, long term consumption of food with a high GI is a significant risk factor for type-2 diabetes patients. However, the GI concept for the general population is still an object of discussions. Fructose is the main sugar in most honey types (Table 1). In rat feeding experiments the hypertriglyceridemic effect observed after intake of fructose does not take place after feeding of honey. Compared to rats fed with fructose, honey-fed rats had higher plasma  $\alpha$ -tocopherol levels, higher  $\alpha$ -tocopherol/triacylglycerol ratios, lower plasma NOx concentrations and a lower susceptibility of the heart to lipid peroxidation. These data suggest a potential nutritional benefit of substituting fructose by honey in the ingested diets. Ingestion of both honey (2 g/kg body weight) and fructose prevented the ethanol induced transformation of erythrocytes in mice. In humans faster recovery from ethanol intoxication after honey administration has been reported while a higher ethanol elimination rate has also been confirmed.<sup>[9]</sup>

### **THERAPEUTIC PROPERTIES OF HONEY**

Meda *et al.* (2004) reported that honey is becoming acceptable as a reputable and effective therapeutic agent by practitioners of conventional medicine and by the general public. Its beneficial role has been endorsed to its antimicrobial, anti-inflammatory and anti-oxidant activities as well as boosting of the immune system.<sup>[10]</sup>

#### **Antimicrobial activity**

The antimicrobial activity is very important therapeutically, especially in situations where the body's immune response is insufficient to clear infection. In other words, it has shown powerful antimicrobial effects against pathogenic and non-pathogenic micro-organisms (yeasts and fungi) even against those that developed resistance to many antibiotics. The antimicrobial effects could be bacteriostatic or bactericidal depending on the concentration that is used. However, such activity has been attributed to certain factors like high osmolarity (low water activity), acidity (low pH), and hydrogen peroxide and non-peroxide components. Furthermore, honey is a supersaturated sugar solution; these sugars have high affinity for

water molecules leaving little or no water to support the growth of microorganisms (bacteria and yeast). The latter method can be carried out by tube dilution or micro dilution in micro titre plates as per the method of Tan *et al.* (2009). However, MIC is considered as the lowest concentration of honey that inhibited bacterial growth (no visible growth or turbidity). Other important effects of honey have been linked to its oligosaccharides. As a matter of fact, *Lactobacillus* spp. protect the body against infections like salmonellosis; and *Bifido* bacterium sp restrict the over-growth of the gut walls by yeasts or bacterial pathogens and, perhaps reduce the risk of colon cancer by out-competing putrefactive bacteria capable of liberating carcinogens.<sup>[10]</sup>

### Anti-inflammatory activity

Although inflammation is a vital part of the normal response to infection or injury, when it is excessive or prolonged it can prevent healing or even cause further damage. The most serious consequence of excessive inflammation is the production of free radicals in the tissue.<sup>[11]</sup> These free radicals are initiated by certain leucocytes that are stimulated as part of the inflammatory process, as inflammation is what triggers the cascade of cellular events that give rise to the production of growth factors which control angiogenesis and proliferation of fibroblasts and epithelial cells. However, the anti-inflammatory properties of honey have been well established in a clinical setting and its action is free from adverse side effects.<sup>[12]</sup>

### Anti-oxidant activity

Antioxidant capacity is the ability of honey to reduce oxidative reactions within the human body. It has been found to have a significant antioxidant content measured as its capacity to scavenge free radicals. This anti-oxidant activity may be at least part of what is responsible for its anti-inflammatory action Manyi-Loh *et al.* 847 because oxygen free radicals are involved in various aspects of inflammation.<sup>[13]</sup>



## NUTRITION AND HEALTH EFFECTS

### Oral health

There is much debate whether honey is harmful to teeth. Some reports show a cariogenic effect of honey or a much less cariogenic effect than sucrose. Due to its antibacterial activity honey ingestion inhibits the growth of bacteria, causing caries and might induce a carioprotective effect. It was shown that Manuka honey, a very potent antimicrobial honey, has a positive effect against dental plaque development and gingivitis and can be used instead of refined sugar in the manufacture of candy.<sup>[14]</sup>

### Gastroenterology

The application of honey for prevention and treatments of gastro-intestinal disorders such as peptic ulcers, gastritis, gastroenteritis has been reported in various books and publications from Eastern and from Arab countries Honey is a potent inhibitor of the causing agent of peptic ulcers and gastritis, *Helicobacter pylori* In rats honey acted against gastric ulcers experimentally induced by indomethacin and alcohol Honey is not involved in prostaglandin production, but it has a stimulatory effect on the sensory nerves in the stomach that respond to A second mechanism of action has been proposed, postulating that this effect is due to the antioxidant properties of honey. Other important effects of honey on human digestion have been linked to oligosaccharides. In clinical studies with infants and children honey shortens the duration of bacterial diarrhoea and did not prolong the duration of non-bacterial diarrhea.<sup>[14]</sup>

### Cardiovascular health

The effects of ingestion of 75 g of natural honey compared to the same amount of artificial honey (fructose plus glucose) or glucose on plasma glucose, plasma insulin, cholesterol, triglycerides (TG), blood lipids, C-reactive proteins and homo cysteine, most of them being risk factors for cardiovascular diseases, were studied in humans. Glucose reduced cholesterol and low-density lipoprotein-cholesterol (LDL-C). Artificial honey slightly decreased cholesterol and LDL-C and elevated TG. Honey reduced cholesterol, LDL-C, and TG and slightly elevated high-density lipoprotein-cholesterol (HDL-C). In patients with hypertriglyceridemia, artificial honey increased TG, while honey decreased TG. In patients with hyperlipidemia, artificial honey increased LDL-C, while honey decreased LDL-C. In diabetic patients, honey compared with dextrose caused a significantly lower rise of plasma glucose.<sup>[14]</sup>

**Infants**

The application of honey in infant nutrition used to be a common recommendation during the last centuries and there are some interesting observations. Honey was better tolerated by babies than and compared to a water based placebo significantly reduced the crying phases of infants. Infants had a higher weight increase when fed by honey than by sucrose, and showed less throw up than the sucrose controls when infants were fed on honey rather than on sucrose an increase of hemoglobin content, a better skin colour and no digestion problems were encountered]. Infants on honey diet had a better weight increase and were less susceptible to diseases than infants fed normally or when given blood building agents.<sup>[15]</sup>

**Allergy**

Honey allergy seems relatively uncommon; allergies reported can involve reactions varying from cough to anaphylaxis In this study it was reported that patients allergic to pollen are rarely allergic to honey, although there is one reported case of combined honey pollen allergy The incidence of honey allergy, reported in a group of 173 food allergy patients was 2.3% [cited in In this study the honey allergy is explained by the presence of components of bee origin.<sup>[15]</sup>

**Honey and wealth**

NH Production and consumption Natural honey productions of high economic importance globally. The cost of honey production is minimal compared with the high returns on the investment. It has been estimated that the global market for wound care annually is between two to six billion US dollars. If part of this huge sum is used to procure the recently developed hi-tech honey dressings, it will go a long way to improve honey production.<sup>[15]</sup> However, little attention is given to this high-yielding enterprise known as apicultural practice. According to the information on honey production and consumption available at <http://www.apiservices.com/>, the present annual world honey production is about 1.2 million tons, which is less than 1% of the total sugar production. The consumption of honey differs strongly from country to country. The major honey exporting countries China and Argentina have small annual consumption rates of 0.1 to 0.2 kg per capita. According to FAO(Food and Agriculture Organization of the United Nations) reports of 2005, China is the world largest producer of honey.<sup>[15]</sup>

## **Honey as food**

### **Nutritional profile**

The composition of honey is mainly sugars and water (Table 1). In addition, it also contains several vitamins and minerals, including B vitamins as shown in Table 2. The other constituents of honey are amino acids, antibiotic-rich inhibited, proteins, phenol antioxidants, and micronutrients.<sup>[16]</sup> The sugars in honey are sweeter and give more energy than artificial sweeteners and the most abundant sugar in honey is fructose. These substances are of nutritional and health importance. Some of the vitamins found in honey include ascorbic acid, pantothenic acid, niacin and riboflavin; along with minerals such as calcium, copper, iron, magnesium, manganese, phosphorus, potassium and zinc. Growth Food is eaten for nourishment, metabolic activities, growth and healthy living. Regular consumption of natural honey gives all these benefits.<sup>[17]</sup>

## **HEALTH BENEFITS OF HONEY**

Since ancient times, honey has been used for its medicinal properties to treat a wide variety of ailments. It may be used alone or in conjunction with other substances and administered orally or topically for the eradication of certain ailments. However, misuse of antibiotics, the emergence of resistant bacteria, high cost and unavailability of some conventional drugs and increasing interest in therapeutic honey have provided an opportunity for honey to be used as a broad-spectrum antibacterial agent. The beneficial actions of honey have been established in the following.<sup>[18]</sup>

### **Honey in the treatment of wounds**

A broad spectrum of wounds is being treated all over the world with natural unprocessed honeys from different sources. At present Medihoney TM (a blend of manuka and jelly bush honey) has been one of the first medically certified honeys licensed as a medical product for professional wound care in Europe, America and Australia. In addition, dressings impregnated with honey under controlled conditions and sterilized by gamma irradiation are available in Australia and New Zealand. Honey is equally found as an active ingredient in products such as ointments for the treatment of minor burns and cuts in Nigeria.<sup>[18]</sup>

### **Cross contamination**

The viscous nature of honey is believed to provide a moist wound environment that allows skin cells to re-grow across the wound as well as it provides a protective barrier that helps safeguard patients by preventing cross contamination.<sup>[19]</sup>

**Stimulation of tissue growth**

The re-growth of tissue is very important in the wound healing process. Honey stimulates the formation of new blood capillaries (angiogenesis), the growth of fibroblasts that replace connective tissue of the deeper layer of the skin and produce the collagen fibers that give the strength to the repair.<sup>[19]</sup>

**Debridement action**

It has been established that dressings that create the type of moist wound environment that honey provides facilitate the process of autolytic debridement. The high osmotic pressure of honey draws lymph from the deeper tissues and constantly bathes the wound bed.<sup>[19]</sup>

**Bioburden**

Honey has shown considerable antibacterial activity against a wide range of wound pathogens as well as against biofilms created by bacteria on wounds (Okhiria et al., 2004). A biofilm may be described as a bacterial community living within a self-produced extracellular polysaccharide (EPS) matrix that protects them from antimicrobial and phagocytic onslaught.

**Anti-inflammatory action**

The anti-inflammatory activity of honey has been documented in clinical studies of human burn wounds and in *in vitro* studies. The potential consequences of effectively managing inflammation include rapid reduction of pain, edema, and exudates; additionally hypertrophic scarring is minimized by avoiding protracted inflammation that may result in fibrosis.<sup>[20]</sup>

**Gastroenteritis**

Acute gastroenteritis is an acute inflammation of the gastrointestinal tract that may be caused by a variety of organisms. Honey has demonstrated bactericidal activity against many enteropathogenic organisms, including those of the *Salmonella* and *Shigella* species.

**Typhimurium infections.**

Most recently, Abdul rhman et al. (2010), in their study, added honey to the oral rehydration solution (ORS) recommended by the World Health Organization/UNICEF(2002) to treat gastroenteritis in infants and children. They reported that the frequency of both bacterial and non bacterial diarrhea was reduced.

### **Gastritis, gastric and duodenal ulcers**

Gastritis, gastric and duodenal ulcers are complications resulting from infection with *Helicobacter pylori*. Conventional treatment for the eradication of *H. pylori* is far from satisfactory; thus there is search for alternative treatment. Honey-derived remedies constitute a potential source of new compounds that may be useful in the management of *H. pylori* infections. In vitro studies suggested that honey possesses bactericidal activity against *H. pylori* and could be used in combination with the antibiotics in the triple therapy in a bid to help eradication.<sup>[20]</sup>

### **Other infections**

Al-waili (2004) in a study reported the usefulness of topical application of honey against Acyclovir for the treatment of recurrent herpes simplex lesions. Also, Kocet al. (2009) in their study demonstrated in vitro that honeys from different floral sources in Turkey had antifungal activity at high concentration of 80% v/v against 40 yeast species.<sup>[21]</sup>

### **NUTRITIONAL BENEFITS OF HONEY**

For a long time in human history, honey was an important source of carbohydrates and the only widely available sweetener (Ball, 2007).<sup>[21]</sup> It is found to be a suitable sweetener in fermented milk product without inhibiting the growth of common bacteria like *Streptococcus thermophilus*, *Lactobacillus acidophilus*, *Lactobacillus delbruekii* and *Bifido bacterium bifidum* which are important for maintaining a healthy gastrointestinal tract. On the account of the nutritional value and fast absorption of its carbohydrate, honey is a food suitable for humans of every age (Blasa et al., 2006). Simply, when orally consumed, its carbohydrates are easily digested and quickly transported into the blood and can be utilized for energy requirements by the human body.<sup>[21]</sup>

### **CONCLUSION**

Due to variation of botanical origin honey differs in appearance, sensory perception and composition. It contains mainly carbohydrates. The glycemic index of honey varies from 32 to 87, depending on botanical origin and on fructose content. The main nutrition- and health relevant components are the carbohydrates, which make it an excellent energy source especially for children and sportsmen. Besides its main components, the carbohydrates fructose and glucose, honey contains also a great number of other constituents in small and trace amounts, producing numerous nutritional and biological effects: antimicrobial,

antioxidant, antiviral, antiparasitic, antiinflammatory, antimutagenic, anticancer and immunosuppressive activities.

Different nutritional studies have confirmed various effects after honey ingestion, e.g. enhanced gastroenterological and cardiovascular health. Besides, honey showed physiological effects on blood health indicators as well as effects on hepatitis A and radiation mucositis patients.

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