

Honey...Prebiotic and Antibiotic

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The definition of honey stipulates a pure product that does not allow for the addition of any other substance. This includes, but is not limited to, water or other sweeteners [1]. Fructose and glucose are the main carbohydrate constituents of honey.

The use of natural honey as food and medicine by mankind has been in existence from time immemorial. In fact, records have it that raw honey is the most ancient sweetener, and it was noted to have been in using throughout the world several million years ago. Natural honey is a sweet, flavorful liquid food of high nutritional value.

Natural honey is produced by honey-bees as blossom honey by secreting nectars of flowers, and honeydew honey (forest honey) by secreting the exudates of plant sucking insects (Aphids). Natural honey is widely embraced by all ages, and its use transcends the barriers of culture and ethnicity. The use of honey is even advocated and embraced by all religious and cultural beliefs. Natural honey is a liquid spoken of by all religious books, and accepted by all generations, traditions and civilizations, both ancient and modern.

In recent years, however, there has been increasing interest in the use of “natural” and “healthy” food additives and incorporating health-promoting substances into the diet. Due to its “healthy” and “natural” [2], image honey has been gaining interest as a substitute sweetener in foods. Honey-sweetened products are viewed as value added and consumers are willing to pay up to 13% more for them compared to products containing other sweeteners [3].

Honey is a viscous solution containing various molecules, including fructose and glucose (80 - 85%); water (15 - 17%); ash (0.2%); proteins and amino acids (0.1 - 0.4%) and trace amounts of enzymes, vitamins and other substances, such as phenolic compounds. However, honey composition varies depending on the types of plants from which the bee consumes nectar. Nevertheless, nearly all honey worldwide contains similar types of phenolic acids, including caffeic, ellagic, ferulic and p-coumaric acids; flavonoids, such as apigenin, chrysin, galangin, hesperetin, kaempferol, pinocembrin and quercetin; and anti-oxidants, such as tocopherols, ascorbic acid, superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH). Each constituent has unique nutritional and medicinal properties, and the components act synergistically, lending honey utility in a variety of applications [4].

Sucrose and corn syrup have been the traditional and most commonly used sweeteners in the dairy industry. Although honey has been added as a flavoring agent to yogurt and ice cream, it is typically not used to replace sucrose or corn syrup in fermented dairy products (that is, yogurt), since it is believed that honey may be inhibitory to lactic starter cultures [3]. As prebiotic, honey contains carbohydrates called oligosaccharides, which may improve gastrointestinal health by stimulating the growth of good bacteria (*Bifidobacteria* in fermented dairy food) in the colon. Honey contains higher amount of oligosaccharide resulted in large amount of beneficial bacteria's growth [5]. In the same trend, Chick, *et al.* [6] stated that honey supported growth of *Streptococcus thermophilus*, *Lactobacillus acidophilus*, *Lactobacillus delbruekii subsp bulgaricus*, or *Bifidobacterium bifidum* similar to fructose or sucrose and was not inhibitory. Lactic acid production was similar for all, except for *bifidobacteria* and was not influenced by sweetener type. Although lactic acid production was enhanced ($p < 0.05$) when *bifidobacteria* were grown in the presence of honey, acetic acid production was not affected. Various oligosaccharides found in honey may be responsible for enhanced lactic acid production by bifidobacteria. Also, Ustunol [7] illustrated that honey enhanced the

growth, activity and viability of commercial strains of *Bifidobacteria* typically used in the manufacture of fermented dairy products. However, this effect was strain-specific. There was a synergistic effect among the carbohydrate components of honey in promoting growth and activity of *Bifidobacteria*. The effect of honey on the growth and activity of intestinal *Bifidobacterium* spp was similar to that of commercial oligosaccharides.

There are various types of honey based on color namely, light, amber and dark. Greenbaum and Aryana [8] studied the effect of light, amber colored and dark honey on the *Lactobacillus acidophilus* counts in frozen desserts. Light honey can be recommended for the manufacturing *Lactobacillus acidophilus* probiotic ice creams thus having a frozen dessert with the health advantageous medicinal properties of honey. On the other side, some few literatures showed the inhibitory effect of honey on lactic acid bacteria. Curda and Plockova [9] suggested that honey obtained from different floral sources shows inhibitory effects on the growth of lactic acid bacteria. Some of the inhibitory effects could be due to the high sugar content which reduces the Aw for microbial growth and the presence of organic acids and hydrogen peroxide. Even though the total fructans were found to be higher in both the wild honeys, the commercial honey supported the probiotic growth very well. This may indicate the presence of other oligosaccharides in the honey which were having prebiotic activity.

A traditional medicine branch, called apitherapy, has developed in recent years, offering treatments based on honey and the other bee products against many diseases. The knowledge on this subject is compiled in various books or on relevant web pages such as www.apitherapy.com, www.apitherapy.org

Inhibitory properties of honey against pathogens such as *Bacillus cereus*, *Listeria monocytogenes*, *Escherichia coli*, *Mycobacterium tuberculosis*, *Salmonella typhi*, *Salmonella typhimurium*, *Shigella* sp., *Staphylococcus aureus*, *Vibrio cholera* and *Helicobacter pylori* have been demonstrated. In addition, honey is reported to have anti-inflammatory [10,11] and anti-cancer activities against breast, cervical [12] and prostate cancers [13] as well as osteosarcoma [14]. Furthermore, honey is traditionally used as an anti-diabetic agent [15].

Microbial inhibition of honey has been attributed to its low pH as well as the presence of enzymes such as glucose oxidase, catalase, and lysozyme. Compounds such as 3,5-dimethoxy-4-hydroxybenzoic acid (syringic acid), methyl- 3,4,5-trimethoxybenzoate, and 3,4,5-trimethoxybenzoic acid and methyl 3,5-dimethoxy-4-hydroxybenzoate (methyl syringate) have been isolated from manuka honey and their antimicrobial properties have been demonstrated by Molan and Russell [16] and Russell, *et al* [17]. Structurally, these aromatic acids are similar to benzoic and 4-hydroxybenzoic acid that are typically used in foods as preservatives to inhibit bacterial growth.

Studies have demonstrated that honey could be a potential agent against oxidative stress disorders including cardiovascular disease, cancer, diabetes, hepatic and renal failure and aging processes. The honey components pathways might be helpful to the health professionals for utilization of honey as dietary supplementation and alternative medicine for the management of diverse oxidative stresses and future drug development. Extensive *in vitro* and *in vivo* studies are therefore required and justified to explore the pharmacological potential of honey as a natural product and of the properties and therapeutic potential of its multiple individual chemical and biochemical components [18].

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