

Antioxidant Properties of Honey: Mechanisms and Clinical Applications

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ABSTRACT

Honey is a natural antioxidant source that has gained popularity in recent years due to its possible health benefits. Its antioxidant properties derive from its unique composition of phytochemicals and other compounds, which work in line to neutralise free radicals and upregulate antioxidant enzymes. This review summarises the composition and antioxidant mechanisms of honey, as well as the *in vitro*, animal, and human evidence for its antioxidant activity. In addition, potential clinical applications of honey's antioxidant properties are discussed, such as its use in preventing chronic diseases, promoting wound healing and skin health, and possibly as an adjunct to cancer therapy. Finally, honey's impact on antioxidant activity as well as its safety and quality are discussed.

Keywords: Honey, Antioxidants, Phytochemicals, Oxidative Stress, Chronic Diseases, Wound Healing, Skin Health, Cancer Therapy, Safety, Quality.

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INTRODUCTION

Honey is a naturally occurring, sweet substance that bees produce from nectar or honeydew. Honey has been used for centuries as a natural remedy due to its numerous health benefits, including its antioxidant properties. Antioxidants are substances that prevent DNA, proteins, and lipids from being damaged by oxidative stress. Honey is rich in antioxidants, including polyphenols, flavonoids, and enzymes, which can protect the body from oxidative stress.

This review aims to examine the antioxidant properties of honey, including its composition, mechanisms of action, evidence of its antioxidant effects, and potential clinical applications. This review will emphasise the significance of honey as a natural source of antioxidants and its potential to aid in the prevention and treatment of diseases caused by oxidative stress.

COMPOSITION OF HONEY

Chemical composition of honey

Honey contains sugars, amino acids, vitamins, minerals, and phytochemicals. The composition of honey varies based on the types of flowers pollinated by bees and the geographic location of their hives. Water, proteins, vitamins, minerals, and antioxidants

make up the remaining components. Honey is composed of approximately 80% carbohydrates.

Honey is primarily composed of the simple sugars fructose and glucose, which provide energy to the body. Additionally, honey contains smaller amounts of sugars such as maltose and sucrose. Honey contains amino acids, which are the building blocks of proteins, in addition to carbohydrates. Honey's amino acid composition can vary based on its floral source, but it typically contains both essential and non-essential amino acids.

There are numerous varieties of honey, each with a distinct flavour and composition. Clover, buckwheat, acacia, and manuka honey are among the most widespread varieties of honey. Additionally, the composition of honey can vary based on processing, storage, and climate.

PHYTOCHEMICALS IN HONEY WITH ANTIOXIDANT PROPERTIES

Honey contains a variety of phytochemicals with antioxidant properties, including polyphenols, flavonoids, and enzymes. Polyphenols are plant-based compounds that have been shown to have antioxidant, anti-inflammatory, and anti-cancer properties. Flavonoids are a type of polyphenol that are abundant in honey and have powerful antioxidant properties. Honey contains enzymes such as catalase and peroxidase, which contribute to its antioxidant activity. It is believed that honey's phytochemical composition contributes to its antioxidant and anti-inflammatory properties.



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Mechanisms of Antioxidant Action of Honey

Multiple mechanisms, including free radical scavenging, upregulation of antioxidant enzymes, and synergistic effects of its antioxidant compounds, have been shown to contribute to honey's antioxidant effects.

One of the primary mechanisms by which honey exerts its antioxidant activity is the scavenging of free radicals. Free radicals are unstable molecules that are capable of causing cell damage and contributing to oxidative stress. Honey contains a variety of antioxidant compounds, such as polyphenols and flavonoids, that can neutralise and stabilise free radicals by donating electrons. Honey's ability to neutralise free radicals reduces oxidative stress and protects cells from damage.

Honey can also increase the activity of antioxidant enzymes, such as Superoxide Dismutase (SOD), catalase, and glutathione peroxidase, which are essential for protecting cells from oxidative damage. These enzymes catalyse the decomposition of Reactive Oxygen Species (ROS) and other harmful compounds, thereby preventing cell damage. Honey has been shown to increase the activity of these enzymes in various tissues, including the liver, kidneys, and brain, thereby protecting these organs from damage caused by oxidative stress.

In addition to its individual antioxidant compounds and the upregulation of antioxidant enzymes, honey demonstrates synergistic effects that boost its overall antioxidant activity. Multiple antioxidant compounds in honey have been demonstrated to work in a complementary and additive manner, resulting in a greater antioxidant effect than would be expected from the individual compounds alone.

Honey's multiple antioxidant mechanisms protect cells and tissues from oxidative stress, which can contribute to the prevention and treatment of a variety of diseases.

Evidence of the Antioxidant Properties of Honey

The antioxidant properties of honey have been demonstrated by *in vitro*, animal, and human studies.

A study published in the Journal of Agricultural and Food Chemistry found that several types of honey, including buckwheat honey, exhibited strong antioxidant activity *in vitro*, as measured by their ability to scavenge free radicals and prevent lipid peroxidation.¹ Other studies have found that honey can protect cells from oxidative damage and increase the activity of antioxidant enzymes *in vitro*.^{2,3}

Additionally, animal studies have shown that honey has antioxidant properties. Al-Waili *et al.* (2006), for example, found that honey-fed rats had increased antioxidant enzyme activity in

the liver and kidneys, as well as decreased lipid peroxidation and DNA damage.⁴ Another study published in the Journal of Food Science and Technology discovered that honey protected rats' livers from oxidative stress-induced damage.⁵

Human studies examining the antioxidant properties of honey have yielded mixed results. Honey can increase antioxidant enzyme activity and decrease oxidative stress markers in humans, according to a number of studies. Alvarez-Suarez *et al.* (2010), for example, found that 21 days of honey consumption increased antioxidant enzyme activity in healthy human subjects.⁶ Other studies, however, have found no significant effects of honey on human antioxidant status.^{7,8}

Overall, the evidence suggests that honey has potent antioxidant activity *in vitro* and in animal models, with some evidence indicating that it also has antioxidant effects in humans. Beretta *et al.* demonstrated that honey's antioxidant activity is comparable to or even surpasses that of other natural antioxidants, such as Vitamin C and E.⁹

Honey's powerful antioxidant activity has been demonstrated *in vitro*. Manuka honey, a type of honey produced in New Zealand, has been demonstrated to neutralise free radicals and inhibit lipid peroxidation *in vitro*.¹⁰ Moreover, honey extracts have been found to reduce oxidative stress and prevent DNA damage in human lymphocytes.

Honey's antioxidant properties have also been investigated in human studies. In a randomised controlled trial, for instance, participants who consumed honey for 21 days exhibited a significant increase in antioxidant activity and a decrease in lipid peroxidation.⁶

Honey has been found to possess comparable or even superior antioxidant activity compared to other natural antioxidants. A study comparing the antioxidant activity of Malaysian honey to that of other natural antioxidants revealed that honey had a higher total phenolic content and greater radical scavenging activity than other tested compounds, including Vitamin C and Trolox.¹ In addition, a study comparing the antioxidant activity of various types of honey found that Manuka honey possessed greater antioxidant activity than the other kinds of honey tested.¹¹

Clinical Applications of Honey's Antioxidant Properties

Honey's antioxidant properties offer potential benefits in various clinical applications, including the prevention of chronic diseases associated with oxidative stress, the use of honey as a topical antioxidant for wound healing and skin health, and its potential as an adjunct therapy in cancer treatment.

Honey's potential role in preventing chronic diseases associated with oxidative stress

The development of chronic diseases such as cardiovascular disease, diabetes, neurodegenerative disorders, and certain cancers is significantly influenced by oxidative stress. Honey is a potential dietary intervention for reducing oxidative stress and preventing these diseases due to its antioxidant properties. Various studies have shown that honey consumption can improve antioxidant status, reduce markers of oxidative stress, and provide protective effects against these chronic diseases.

Use of honey as a topical antioxidant for wound healing and skin health

Honey has been used as a wound healer in traditional medicine for centuries. Honey's antioxidant compounds reduce inflammation and stimulate tissue regeneration. Additionally, honey's antimicrobial properties prevent wound infections. Honey promotes wound healing, particularly in chronic and infected wounds, burns, and surgical sites, according to studies.^{12,13} In addition, honey's antioxidant properties can contribute to its use in skin care products for preserving skin health and reducing oxidative damage.

SAFETY AND QUALITY CONSIDERATIONS

Honey is generally considered safe for human consumption, but there are a few precautions to take. Honey may contain spores of the bacterium *Clostridium botulinum*, which can grow and produce botulinum toxin under certain conditions, such as in infants younger than one year or in those with compromised immune systems (EFSA Panel on Biological Hazards, 2019).¹⁴ In addition, some people may be allergic to honey or its components, resulting in allergic reactions.

In terms of honey's antioxidant properties, considerations of quality are also essential. Variables such as bee forage, harvesting techniques, and processing techniques can affect the composition and quality of honey. These variables can have an effect on the phytochemical composition and antioxidant capacity of honey. Khalil *et al.*, found that darker honey varieties have generally higher antioxidant activity than lighter varieties.¹ Therefore, it is essential to choose high-quality honey that has been processed and stored properly in order to maximise the antioxidant benefits.

In addition, it is essential that honey is not adulterated with substances such as sugar or corn syrup, which can alter its composition and quality. Adulterated honey may not contain the same levels of antioxidants as pure honey and may pose safety risks.

Honey is generally considered safe for consumption, but it is important to be aware of potential safety concerns and to choose

honey of the highest quality to maximise its antioxidant effects. Honey should be processed and stored properly, and precautions should be taken to prevent adulteration.

CONCLUSION

Honey is a natural antioxidant source that has been linked to a variety of potential health benefits. Its antioxidant properties derive from its unique composition of phytochemicals and other compounds, which work in tandem to neutralise free radicals and upregulate antioxidant enzymes. Honey may be useful for preventing chronic diseases associated with oxidative stress, promoting wound healing and skin health, and possibly even as an adjunct to cancer therapy, according to evidence from *in vitro*, animal, and human studies.

To fully comprehend the mechanisms of honey's antioxidant activity and to determine the optimal dosage and mode of administration for various clinical applications, additional research is required. In addition, more research is required to determine the effect of processing methods, storage conditions, and adulteration on honey's antioxidant properties.

Honey remains a promising natural antioxidant source with potential clinical applications despite these limitations. By choosing high-quality honey and incorporating it into a balanced diet and healthy lifestyle, individuals may be able to reap the antioxidant benefits of this delicious and sweet food.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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