Review Article

A review of pharmacology and medicinal properties of honey

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Abstract

Since centuries ago, people have valued honey, a naturally sweet substance made by bees from the nectar of flowers, for its therapeutic and nutritional benefits. The objective of this review paper is to thoroughly analyze the pharmacological and therapeutic properties of honey. Honey's complex chemical make-up, which includes sugars, enzymes, phenolic compounds, vitamins, and minerals, contributes to its medicinal versatility. Honey has been used historically as a folk cure for a variety of illnesses, and both conventional and modern medicines have recognized its efficacy. The antibacterial,

anti-inflammatory, antioxidant, wound-healing, and immune-modulatory properties of honey are discussed in this article, with an emphasis on how it can be used to treat illnesses like digestive problems, respiratory infections, skin wounds, and more. Honey's molecular interactions with biological pathways are being examined, offering light on the mechanisms behind honey's medicinal effects. A thorough comprehension of honey's pharmacological properties is essential for its incorporation into evidence-based medicine as interest in natural therapies rises. In order to effectively utilize the therapeutic potential of honey, more study is necessary to understand specific pathways, improve dose forms, and establish standardized protocols.

Key words

Honey, Nutritional values, Traditional uses, Medicinal properties.

Introduction

Honey (Apismellifera; Family: Apidae), a golden elixir created by nature's crafty pollinators, has piqued human curiosity for approximately 5500 years [1, 2]. In addition to its delicious sweetness, honey has long been appreciated for its possible therapeutic benefits. Ancient Egyptians praised honey as a cure-all, and Ayurveda and traditional Chinese medicine both used it as part of their therapeutic regimens [2, 3]. It has recently been discovered that this natural material contains a complex tapestry of pharmacological and therapeutic properties as a result of the fusion of conventional wisdom and contemporary scientific study.

A truly extraordinary gift from nature, this golden elixir is made by bees from the nectar of flowers and maintains a significant position in several industries, including cosmetics, medicine, and nutrition [4, 5]. Honey is a revered and healthy food that transcends gender and age in the world of nutrition. Honey has established itself as a treasured food staple, appealing to both men and women across generations [6]. Its great shelf life adds to its enduring appeal; honey's natural composition eliminates the need for refrigeration, and it is known to hold up well over time even when kept at room temperature in a dry atmosphere [7, 8]. Since ancient times, honey has been used as a preferred natural sweetener, which is one of its most beloved purposes. The sweetness of honey, which is high in fructose, has been prized by cultures all over the world [9].

Nowadays, you can find information on using honey to treat a number of human problems in general periodicals, journals, and natural product brochures that also advise a wide range of unidentified activities [10]. The purpose of this review article is to give a thorough overview of the pharmacology and therapeutic benefits of honey by combining knowledge from both traditional medicine and more recent scientific research. Honey may have protective effects on the respiratory, gastrointestinal, cardiovascular, and neurological systems, as well as antioxidant, anti-inflammatory, antibacterial, antiviral, and antibacterial properties [11-16].

Honey has become a leading competitor for its wide range of therapeutic uses as the need for complementary and alternative therapies picks up steam. Interest has been generated by its antibacterial, anti-inflammatory, antioxidant, and wound-healing properties across medical specialties. The resurgence of honey as a potential all-natural defense against microbial dangers has been sparked by the growth of antibiotic resistance. Additionally, it has attracted interest in the fields of dermatology and wound care due to its involvement in accelerating wound healing and tissue regeneration.

Honey beckons as a topic suitable for investigation because it has a historical past intertwined with human well-being and a

growing corpus of scientific information. We strive to close the gap between traditional knowledge and contemporary scientific understanding by digging into its pharmacological complexities and illuminating the processes underlying its therapeutic effects. In order to fully realize honey's therapeutic potential, more research is necessary. This study aims to provide a thorough synthesis of the present state of knowledge on honey's pharmacological properties and medical uses.

Nutritional value of honey

There are currently about 300 recognized varieties of honey [17]. These variants are connected to the many kinds of nectar that honeybees gather. Honey's primary component is carbohydrates, which account for 95–97% of its dry weight. In addition, honey contains important substances such organic acids, proteins, vitamins, and amino acids [18, 19]. The nutritional components present in honey are enlisted in the table below (**Table - 1**).

Table - 1: Nutritional components present in honey (100 ml) [20]

No.	Nutrients	Measure
1	Sugar	82.1 gm
2	Glucose	35.8 gm
3	Fructose	40.9 gm
4	Calories	304
5	Carbohydrates	82.4 gm
6	Fat	0
7	Proteins	0.3 gm
8	Fibres	0.2 gm
9	Iron	0.42 mg
10	Zinc	0.22 mg
11	Copper	0.036 mg
12	Sodium	4 mg
13	Magnesium	2 mg
14	Potassium	52 mg
15	Phosphorous	4 mg
16	Selenium	0.8 mg
17	Manganese	0.08 mg

Medicinal properties of honey

Honey for wound healing

Honey is a steadfast example of nature's medical wisdom in the field of wound healing, where modern medicine has seen the rise and fall of many substances. Honey is the world's oldest known wound-healing medicine, with a history that dates back through the pages of history, and its efficacy has stood the test of time [21]. Honey's diverse bioactivities are what distinguish it as a wonderful wound healer. Its enormous potential has been revealed by experimental researches, which show a variety of actions that contribute to its potency in wound care. These bioactivities include antimicrobial traits to fight infections, antiviral defenses against virus dangers, anti-inflammatory traits to control inflammation, and antioxidant traits to assist prevent oxidative stress [22]. The tissue repair cascades are started when honey causes leukocytes to produce cytokines. Additionally, it stimulates immune defense against infection [23]. It is also known that honey can stimulate the immune system's other components, including phagocyte activity and B- and T-lymphocyte proliferation. It exhibits the unique ability to stimulate the body's manufacture of antibodies, demonstrating that its medicinal potential goes beyond just its capacity to heal wounds. Its diverse therapeutic potential is further enhanced by its immunomodulatory impact, cementing its status as a natural remedy. According to scientific research, honey can be used to treat and manage a variety of wound types. It demonstrates effectiveness in treating acute wounds as well as meeting the demands of people who have mild to moderate partial-thickness burns and superficial wounds. The empirical evidence from these studies emphasizes the usefulness of honey as a flexible wound care agent in real-world applications [24]. Although multiple studies have suggested that honey is useful in the treatment of leg ulcers and a variety of wounds, the search for rigorous science and complete data continues. To strengthen the already-existing body of information, improve protocols, and build a more

solid foundation for the use of honey in wound care, more study is required.

Honey for gastrointestinal problems

Honey has gained recognition as a potential treatment for a variety of gastrointestinal conditions, including dyspepsia, periodontal and dental diseases, and even plays a part in oral rehydration therapy thanks to its wide range of therapeutic characteristics. Honey has drawn interest as a potential treatment for dyspepsia. Dyspepsia, which is characterized by persistent or frequent pain or discomfort in the upper abdomen, frequently poses difficult management problems. Although concrete evidence is still elusive, honey has been investigated as a potential medicinal alternative [25]. It's also important to note how honey affects oral health. Honey has been suggested as a viable supplementary treatment for periodontal and dental conditions, which can cause mouth discomfort and more serious systemic health problems. Although more research is required before drawing firm conclusions, its antibacterial and anti-inflammatory characteristics may help to improve dental hygiene and gum health. Honey has the ability to treat Helicobacter pylori, bacteria linked to gastritis and peptic ulcers, as well as other gastrointestinal illnesses. Despite the unfavorable outcomes of a clinical experiment using manuka honey to eradicate Helicobacter, in vitro research suggests that honey has bactericidal capabilities against Helicobacter pylori, pointing to its potential use in treating these illnesses [26, 27]. Another intriguing option is honey's ability to treat gastroenteritis, particularly in situations involving children. Clinical trials have demonstrated that honey has therapeutic advantages that can significantly reduce the length of diarrhoea in patients, especially infants and kids who are admitted to the hospital with gastroenteritis. These results imply that honey may be useful in treating gastrointestinal conditions, especially in young children [28]. Additionally, the value of honey in oral rehydration therapy cannot be understated. It is a good contender for aiding in fluid and electrolyte replacement during diarrhoea or dehydration due to its distinctive makeup, which incorporates carbohydrates and electrolytes. The therapy of digestive disorders can be aided by adding honey to oral rehydration solutions, which can make them more palatable and potentially increase patient compliance [29].

Honey for cancer

The potential function of honey in the fight against cancer has recently come to light, shedding light on a variety of mechanisms by which this natural material may exercise its anticancer properties [30]. These mechanisms cover a wide range of complex biological pathways, each of which contributes to honey's potential as a treatment for different cancers. Honey's capacity to disrupt cell signaling pathways, including those linked to apoptosis (programmed cell death), anti-mutagenic effects (preventing DNA mutations), anti-proliferative effects (inhibiting cell growth), and anti-inflammatory effects (reducing inflammation) [30], is one of its remarkable qualities in cancer research. Honey has the ability to slow the spread of cancer and stimulate cellular responses that prevent tumor growth by altering these important pathways. Numerous studies have shown that honey is effective at stopping cell growth, causing apoptosis, altering cell cycle progression, and depolarizing mitochondrial membranes in a variety of cancer cell types. These discoveries cover a broad range of cancer types, including skin cancer (melanoma), adenocarcinoma epithelial cells, cervical cancer, endometrial cancer, liver cancer, colorectal cancer, prostate cancer, renal cell carcinoma, bladder cancer, and human nonsmall cell lung cancer cells [31–40]. Additionally, honey has shown promise in animal models as a preventive treatment for a number of tumor types, including bladder cancer, liver cancer, melanoma, colon cancer, breast cancer, and carcinoma [30]. These preliminary investigations highlight honey's potential to act as a preventative measure against the growth of cancer.

Honey for asthma

In traditional medicine, honey is frequently used to cure fever, coughs, and inflammation [41]. The ability of honey to function as a preventative agent to stop the development of asthma or to lessen asthma-related symptoms was demonstrated. In animal models, oral ingestion of honey was used to cure bronchitis and bronchial asthma. According to Kamaruzaman and colleagues' study, honey therapy significantly decreased the histological changes in the airways associated with asthma. This implies that honey may contribute to reducing the structural alterations in the airways linked to asthma, thus providing comfort to people suffering from this respiratory illness. The study also found that honey therapy could prevent asthma from being induced, emphasizing its usefulness as a preventative measure in this situation. Asthma and chronic obstructive pulmonary disease (COPD) both exhibit goblet cell hyperplasia, a condition that is characterized by the excessive synthesis and release of mucus by goblet cells in the airways. Honey has also been a powerful tool for resolving this problem. Honey may assist in lowering mucus production and enhancing the airway's clearance mechanisms by reducing goblet cell hyperplasia. As a result, people with respiratory disorders may experience improved respiratory function and less burdensome excessive mucus discharge. These results highlight honey's varied and multidimensional contribution to respiratory health. These studies provide encouraging insights into honey's potential as a natural treatment for respiratory illnesses, even if more research is necessary to determine the precise processes underlying its effects on goblet cell hyperplasia and asthma-related histological alterations. The therapeutic potential of honey is still being explored, opening up new fields of study and creative methods for treating respiratory conditions [42].

Honey for diabetes

There is substantial evidence that honey has positive effects in the management of type 2 diabetes [43]. These findings highlight the therapeutic potential of adding honey or other powerful antioxidants to traditional anti-diabetic medications to manage diabetes mellitus. Diabetes care calls for a diverse strategy frequently because it is a complex metabolic illness. Although the use of medicines to lessen the generation of reactive oxygen species (ROS) is an intriguing way to augment current treatment approaches, conventional diabetes medications still serve as the cornerstone of care. In this situation, honey has become a topic of scientific investigation and may be helpful in managing diabetes. Regarding the effect of honey on glycemic control in people with diabetes, clinical investigations have produced some significant findings. In one such study, which included patients with Type 1 and Type 2 diabetes, it was found that honey application resulted in a considerably reduced glycemic index when compared to sucrose or glucose, indicating its potential value in controlling blood sugar levels [44]. Honey has been shown to considerably lower plasma glucose levels in diabetic patients when compared to dextran, further emphasizing its potential as a glycemic control agent [45]. Sugar, glucose, and honey all have comparable glycemic values in Type 2 diabetes. Honey has a greater promise in easing diabetes-related problems than only its impact on blood sugar. It has been demonstrated to lower levels of blood homocysteine, C-reactive protein, and cholesterol, especially in people with both normal and hyperlipidemic situations. These effects on cardiovascular risk variables point to honey's varied function in treating metabolic problems associated with diabetes [46]. While the potential benefits of using honey to manage diabetes are exciting, it's important to note that there are still a lot of unsolved issues. Further research is needed to better understand how oxidative stress and hyperglycemia interact as well as the possibility for treatments that address both facets of diabetes. Additionally, honey's therapeutic advantages in the therapy of diabetes may go beyond glucose control to include a wider range of metabolic consequence illnesses.

Honey for neurological diseases

Honey is one such promising nutraceutical antioxidant, and there is significant scientific literature that supports the use of nutraceutical substances as innovative neuroprotective therapeutics [46]. In addition to reducing oxidative stress on the central nervous system, honey has anxiolytic, depressive, anticonvulsant, and antinociceptive properties. According to a number of studies, honey polyphenols may have nootropic and neuroprotective effects [47]. In order to reduce biological reactive oxygen species (ROS), which are known to accelerate ageing and cause a number of age-related disorders, honey's polyphenolic components are crucial. Honey's polyphenols have the ability to slow down ageing and lower the risk of age-related disorders by lowering the negative effects of ROS [48]. The neurological system is seriously threatened by neurotoxicity, a phenomenon that is characterized by damage to the nervous system brought on by exposure to toxic substances. It has been demonstrated that the polyphenolic components of honey offer defence against direct apoptotic threats, such as those brought on by retinoid chemicals, methyl mercury, and amyloid beta. This protective response suggests that honey may help protect neuronal health and lessen the negative effects of neurotoxic drugs [49].

Neuro-inflammation brought on by microglia is a key player in the aetiology of many neurological diseases. Microglia can over activate in response to immunogenic neurotoxins or ischemia injury, releasing pro-inflammatory chemicals and causing oxidative stress, which can worsen neuronal damage and dysfunction. Studies have shown that raw honey and the polyphenolic compounds in it can reduce neuroinflammation brought on by microglia. Honey and its polyphenols provide a promising route for lowering neurotoxicity and preventing the evolution of neurological illnesses such neurodegenerative diseases by modifying the activity of microglia and reducing the inflammatory response [50]. The hippocampus, a part of the brain involved in memory, is the brain region where honey polyphenols have the greatest impact on reducing neuro-inflammation [51]. At the molecular level, honey polyphenols promote memory formation and prevent memory problems. According to several studies, the memory-improving and neuropharmacological effects of honey are caused by changes in particular brain circuitry. To ascertain the precise biochemical effect of honey on mitochondrial malfunction, necrosis, apoptosis, excitotoxicity, and neuroinflammation, more research is necessary. Additionally, antinociceptive, anxiolytic, anticonvulsant, and antidepressant effects should be thoroughly investigated.

Honey for cardiovascular diseases

Honey contains a variety of antioxidants, including flavonoids, polyphenols, vitamin C, and monophenols, which may help lower the risk of cardiovascular failure. By reducing oxidative stress and supporting many aspects of heart function, these natural substances are essential for preserving cardiovascular health. The protective effects of flavonoids, such as antioxidant, antithrombotic, anti-ischemic, and vasorelaxant properties, in coronary heart disease decrease the risk of coronary heart disorders through three mechanisms: (a) enhancing coronary vasodilatation, (b) lowering the ability of blood platelets to clot, and (c) inhibiting low-density lipoproteins from oxidising. Depending on the honey's botanical and geographic origins, the antioxidant content can change. While there is a wide range of antioxidants present in different types of honey, some substances are more common and have attracted attention for their possible pharmacological benefits in reducing the risk of cardiovascular illnesses. Among the important polyphenolic antioxidants contained in honey are caffeic acid, quercetin, phenethyl ester, kaempferol, galangin, and acetin. These substances have shown a variety of bioactive traits that are important for cardiovascular health, such as antioxidant, anti-inflammatory, and vasoprotective actions. Although there is mounting evidence from in

vitro and in vivo studies supporting the cardiovascular advantages of honey polyphenols, clinical trials must be started to confirm their effectiveness in medical settings. Clinical studies offer a more thorough and accurate evaluation of these drugs' medicinal potential in human beings. Researchers can examine the precise effects of honey polyphenols on cardiovascular health, including their impact on blood pressure, lipid profiles, endothelial function, and overall cardiovascular risk, through well planned clinical trials. These studies can offer important information about the best honey polyphenol dosages, treatment schedules, and safety profiles for the prevention and treatment of cardiovascular disease.

Conclusion

In conclusion, honey stands out as a viable natural resource with outstanding pharmacological and therapeutic properties. Modern scientific study confirms the usefulness of its ancient use as a traditional treatment in a number of different health applications. Honey's antibacterial, anti-inflammatory, and wound-healing capabilities are attributed to its bioactive components, which broaden its medicinal application beyond simple dietary needs. Although honey's promise is clear, more thorough research is still required to completely understand its mechanisms of action, establish standard therapeutic dosages, and determine whether it is compatible with modern medical procedures. Traditional knowledge and contemporary research approaches must work together for honey to be included in standard medical procedures. The pharmacology of honey serves as a testament to the riches of what nature has to offer as the globe searches for affordable and sustainable healthcare solutions. Therefore, this review emphasizes the significance of on-going study into the subtleties of honey's pharmacology, encouraging its use as an important complement to traditional medicinal techniques.

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