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ROLE OF HONEY AS AN ANTIMICROBIAL AGENT

Review Article

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ABSTRACT

Background: A natural substance produced by honey bees called honey, has been used for hundreds of years for its medicinal, therapeutic and nutritional properties. The use of honey extends back to early cultures, with evidence of its application in traditional medicine wound healing and food preservation. The antimicrobial properties thoroughly researched along with its composition including low water content, high sugar content, acidity, pH, hydrogen- peroxide and non-peroxide compounds.

Objective: This review provide an overview of the potential benefits and applications of honey as antimicrobial agent, bringing attention to its potential as an natural, effective and resilient solution for various health related issue.

Methods: The comprehensive review of existing literature on honey as an antimicrobial agent was conducted studies published up to 2020 were retrieved from Google Scholar. For this review many articles were studied based on honey's composition, antimicrobial and therapeutic properties.

Conclusion: Honey is a versatile natural substance with wide range of therapeutic properties such as antimicrobial, antiviral, antibacterial and anticancer activities. Its unique composition includes low water content and hydrogen peroxide which adds to its antimicrobial activity all was discussed in this review.

Keywords: Honey, Manuka, therapeutic properties, antimicrobial properties, wound healing, anticancer properties, antiviral properties.

INTRODUCTION

Honey word is basically derived from Latin word “melem” (1). Honey is an organic material synthesized by honeybees known as “Apis mellifera” from the essence of flower that is sugary delicious sticky liquid. Honey is a complicated blend and offer changes in constitution and traits due to its location and changes in the flowers from which the bees extracted pollen (2). Honey bees, as individual insects, show a high tolerance to heat stress. While flying, the temperature of their thorax can reach up to 49 °C and they are capable of surviving for 24 hours at 45 °C (3).

Honeybees make honey via complicated procedure that start with gathering raw material either floral nectar (known as blossom honey) sugary discharge straight from insects as basic component which is preserved and manufactured in their honeycomb. The bees lose moisture, and improve their floral extract by the excretion of particular enzymes to disintegrate sugar. Now the improved version of blossom juice is formed into honey (4). The composition, properties and smell of honey is greatly influenced by origin of plants and the geographical area from where the nectar is collected by bees (5). It was observed that honey may darken during storage, which could be related to its composition and the storage temperature. A link was also found between the color and flavor of honey and its mineral content. Additionally, the mineral content of honey also influenced its acidity (6).

Pure honey consists of 82% of water, carbohydrates, protein, phytochemicals, antioxidants, and minerals. It has been verified that some of the elements sets the biological and medical ability of this mixture that is different from type to type (7). The sugars in honey contain fructose, glucose, sucrose, hydrogen- peroxide, polyphenol. The power of honey against microorganism is as certain by different factors such as bees environment and composition of honey (8). Hydrogen peroxide in honey mainly plays the important role in its antimicrobial properties. Due to its presence in honey it is used for the treatment of wounds and gastrointestinal disease. Phenolic compounds and non-peroxide are also somewhat responsible for the antimicrobial properties of honey (9).

The first use of honey as a medicine was reported in the book called Edward Smith Papyrus 4000 year ago in Egypt. At that time people use vegetal fibers mix with fat and apply on wounds. Till now honey is being used for wounds healing (10). In Muslim countries the interest of honey is developed probably because of our holy book in which honey is described as palliative for humanity and referred as food of paradise in surah “AL-NAHL” so it has been used since ancient time as medicine (11). Worldwide honey has been used for different purposes for example Egyptians consider bees to be sacred and implemented honey in wide range of medicines i.e. wound healing. In Christian culture they had faith that honey is the blessing of God that brought peace to brain and soul (12).

This review explains honey’s antimicrobial properties, its natural composition, its therapeutic properties which include wounds healing, anticancer, antibacterial and antiviral properties. The review highlights the factors that contribute to antimicrobial properties of honey which include hydrogen peroxide, non-peroxide compounds, acidity, pH and high sugar content. It also briefly discussed the challenges and future directions associated with the use of honey as an antimicrobial. Hence the purpose of this study is to summarize honey and its role as an antimicrobial agent.

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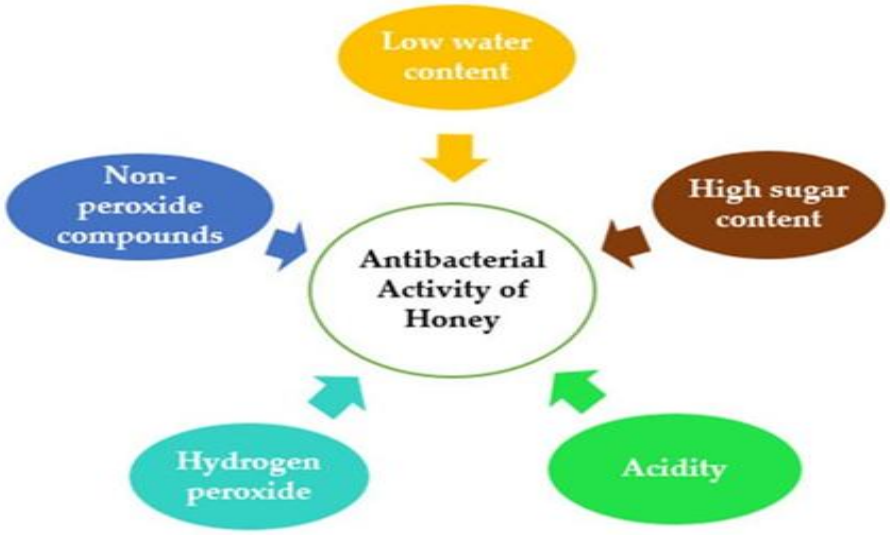
Factors Contributing to the Antimicrobial activity of honey

Antimicrobial activity of honey depends upon various factors which includes low water content, high sugar continent, acidity, hydrogen-peroxide and non-peroxide compounds.



This figure is from (13).

Low Water Content

Honey's water activity is estimated to be around 0.562-0.62 by measuring its free water molecules. This low water content falls below the 0.94-0.99 value which is essential for bacterial growth, making honey an environment for microorganisms (13).

High Sugar Content

Honey contain high amount of sugar, mono-saccharides holds about 75% and di-saccharides has 10-15%. Mono-saccharides include fructose and glucose. These sugars contribute the energy value of honey along with its thickness, granulation and capacity to absorb moisture (14).

Acidity and pH

It was previously though that bees added bee venom (which contains the chemical formic acid) as a preservative to honey. However research showed that there are actually different acids in honey, primarily malic acid and citric acid. Well, honey is a buffer its resist change in pH even when little bit of acid and basis are added. Phosphates, carbonates and some minerals salts acoounts for that buufering capacity [2].

Hydrogen peroxide

Honey's antimicrobial properties are driven from the production of hydrogen per oxide, which skillfully inhibits and kills bacteria. The level of H2O2 produced is directly related to honey antimicrobial efficacy as measured by its minimum inhibitory concentration (MIG) and minimum bacterial concentration (MBG). The glucose oxidation reaction catalyzed by honeybee glucose oxidase (GOx) yields gluconic acid and hydrogen peroxide, with enzyme concentration and activity determining product levels. However, conflicting observation have appeared regarding the relationship between GOx activity and H2O2 concentration in honey (15).

Non-peroxide compounds

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The Secondary metabolites of plants are known as Non-peroxide compounds (polyphenols). These biological compounds are transferred from nectar to honey and our essential components of honey therapeutic properties. Phenolic compounds are present in abundant amount in honey and play an important role in its antimicrobial property (16).

Therapeutic Properties

Wound Healing

Honey is a very complex natural substance, containing many compounds. Its composition, which largely depends on floral source, season, environment, and processing–handling–packaging–storage conditions, together with its bioactivity contribute to the therapeutic potential of honey for wound healing. In addition to some of its intrinsic physicochemical properties such as general acidity and osmotic pressure, the medicinal properties of honey on different wound types and burns are closely associated with the beneficial actions of different individual components that work via distinct mechanisms to modulate the physiological healing of damaged tissues (17). Honey is being used as a source for medicine and food for ages. It has also been used to treat cuts, burns and traumatic wounds. In 2007, the Federal Drug Administration (FDA) approved that a Manuka honey (MH)-based medication, for treating different types of wounds (18).

Anticancer Properties

The key ingredients of honey play an important role in cancer managing by influencing the cells signaling pathways. Animals study suggests that by honey treatment the growth of the breast cancer tumor can be delayed, which result in the smaller tumor size compare to the untreated groups of tumor (19). In vivo studies are few which explore the potential of honey to prevent or inhibit the development of liver tumor. The effect of honey on growth and progression of diethyl-nitrosamine (DEN) induced hepatic cancer in rats was studied. Rats treated with honey remained free of liver abnormalities six month later. Yet, the liver of the honey-treated rats demonstrated a markedly decrease in these irregularities. This evidence of study showed that honey protect rats from chemical liver cancer and exhibit anti-cancer property against liver cancer cells(20).

Antibacterial Properties

The antibacterial activity and mechanisms of action in honey are attributed to its flavonoids content, osmolarity, acidity and the presence of the inhibitory compounds in such as hydrogen-peroxide (21). Phenolic compounds are responsible for the antibacterial action in honey. Methyl syringate is specifically responsible for neutralization of superoxide free radicals, thus increasing the antibacterial action of honey (22).

Anti-viral Properties

Honey is a highly effective treatment for Zoster rash due to its ease of use, accessibility, and low cost. Both clover and Manuka honey have displayed antiviral effects against the virus, highlighting honey's strong antiviral properties (23). Flavonoids in honey like quercetin inhibit the extension of viruses, whereas polyphenols decrease the tissue damage by the reducing inflammatory responses (24). Honey and propolis have also been found to exhibit antiviral effects against several human pathogenic viruses, including the influenza virus, respiratory syncytial virus (RSV), human herpesviruses, HIV, human T-cell leukemia-lymphoma virus type 1 (HTLV-1), Newcastle disease (NDV), poliovirus type 1 (PV-1), and dengue virus (DENV) (25).

Challenges and Future Directions

Honey encounters many challenges when it comes to its quality, safety and efficacy. Quality control and standardization is foremost barrier faces by honey products. The difference in honey composition is due to the various factors such as geographical location, floral source and production methods, due to these factors the uniform quality standards of honey are not achieved (26).Antimicrobial resistance is one of the most serious challenge for humans. The use of honey products are promising natural antimicrobial agents, because they not only act against both gram negative and gram positive bacteria but also fungi and biofilms. The dosage and the safety are major problems using these products.

Future directions of honey as an antimicrobial agent involve clinical use, mode of action, standardization and quality control. It is also critical to investigate potential resistance, safety concerns and to develop innovative delivery system. Moreover, therapeutic potential will be enhanced by combining honey based treatments with conventional antibiotics and establishing regulatory frameworks.

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CONCLUSION

Honey has been shown to be effective against many microorganisms including virus, bacteria and fungi also, has therapeutic applications in wound healing cancer treatment, and antibacterial and antiviral therapies. Further research and studies are needed to fully explore the therapeutic potential of honey and to better understand its mechanism of action. However the current researches suggest that honey is valuable natural resource with a wide range of health benefits.

Author Contributions

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Mehar Roshni	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Munazza Nadeem	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Azka Mubeen*	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Ijaz Ahmad	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
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Faizan Hameed	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Muhammad Mudassar	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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