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Review Article

Medicinal properties of honey: A review

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ABSTRACT

Honey has long been a valuable natural resource, used as a nutritional supplement and in traditional medicine to treat various ailments. Its antioxidant, antibacterial, anti-inflammatory, and anti-proliferative properties have been linked to treating wound healing, diabetes, cancer, asthma, neurological, gastrointestinal, and cardiovascular disorders. Honey contains flavonoids and polyphenols, the primary bioactive chemicals with antioxidant qualities. It is commonly accepted as mostly food and traditional medicine by all generations, both ancient and modern. Honey and its byproducts are commonly used in Asian countries, such as China, India, Sri Lanka, Nepal and Pakistan, in their traditional medicinal systems. Modern scientific literature suggests that honey may be beneficial for treating various diseases, including cancer, and should be used in clinical wards. The objective of this study is to thoroughly review and synthesize existing literature on the medicinal properties of honey, focusing on its effectiveness in treating several diseases and its potential applications in modern clinical frameworks. By emphasizing on the bioactive compounds and their health benefits, this review seeks to encourage the integration of honey in therapeutic practices.

Keywords: Honey; medicinal properties; antimicrobial activity; cardiovascular diseases; antioxidant; wound healing; fertility**.**

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INTRODUCTION

Bees use the nectar of flowers to make honey. By regurgitating and evaporating nectar, bees convert it into honey, which they subsequently store in wax honeycombs inside the hive as their primary food supply (Kratz, 2022) The glucose and fructose (monosaccharide), which are similar in taste to granulated sugar, make the honey sweet. Its unique chemical properties make it ideal for baking, and many prefer it as a sweetener over sugar and other alternatives because of its unique flavor (Cannas et al*.,* 2024). Honey's medicinal and nutritional properties have been well-established for many years. It has been employed in many contexts, including as a taste enhancer and sweetener. Worldwide, honey contains fructose and glucose, its two main constituents. Honey is widely recognized for its capacity to support skin graft adhesion and healing and its antibacterial, antioxidant and anti-inflammatory qualities (Almasaudi, 2021; Iftikhar et al*.,* 2023). These properties are acknowledged by scientific literature, which proves honey's benefits as an antioxidant and antibacterial, as well as its ability to prevent coughing, promote reproduction, and heal wounds (Meo et al*.,* 2017). There is still debate over the safety of honey, especially for persons with metabolic diseases, despite many people believing it to be a beneficial complementary therapy. Honey's nourishing and active properties make them considered indispensable.

The numerous health-promoting compounds found in honey include thiamine, folic acid, biotin, tocopherol, niacin, phytosterols, polyphenols and a wide range of enzymes and co-enzymes (Sharma et al., 2024; Reddy et al., 2019). Alfarisi et al. (2021) and Iftikhar et al. (2023) have demonstrated that honey possesses antioxidant, antibacterial, antifungal and hepatoprotective properties. In conclusion, honey is a beneficial dietary supplement for those in good health. Muhammad et al. (2016) also emphasized honey's biological properties and possible health advantages.

Before the time of the Ancient Egyptians, people used honey topically to treat various illnesses. (Liyanage and Mawatha, 2017). However, the chemical basis for honey's antimicrobial and antibacterial qualities has been discovered lately. Honey was included in therapeutic formulations by Ancient Egyptian physicians approximately 5,000 years ago (Çelik and Aşgun, 2020). Honey was highly prized by the ancient Greeks, who thought it might increase longevity and vigour (Gibbs *et al*., 2008). Since ancient times, honey has been utilized in traditional Chinese medicine, and its significance is still felt today (Wenli et al., 2021). Manuscripts from antiquity in Russia emphasized the therapeutic value of honey. Islamic texts, especially the Quran, commend honeybees for their "intelligence, industry, and creativity," pointing out the therapeutic properties of honey (Aziz, 2024; Hashim and Abdullah, 2017).

According to the Quran, "And thy Lord taught the Bee to build its cells in hills, on trees, and in (men's) habitations; Then to eat of all the produce (of the earth), and find with skill the spacious paths of its Lord: there issues from within their bodies a drink of varying colours, wherein is healing for men: verily in this is a Sign for those who give thought" [Al-Quran 16:68-69] (Saulawa and Hamisu, 2018). Prophet Muhammad also mentioned the therapeutic properties of honey, asserting that it could heal all ailments. A Muslim physician wrote about the health benefits of honey in the 12th century. These included distributing bodily fluids, easing constipation, treating dropsy, reducing facial spasms, boosting appetite, and maintaining muscular mass. (Salama and Chennaoui, 2024). Saxons began using honey to heal the sites, wounds and amputated limbs about 1000 BC. It was mixed with alum in 1446 to cure ulcers, and by 1623, it was used as a mouthwash and antiseptic. The medicinal benefits of honey expanded throughout Europe during the Middle Ages, particularly in Germany, Finland, England, Germany, Finland, and Ireland. It also reached the United States, Ghana, Nigeria, Nepal, Brazil and Russia. During the Second Balkan War in 1913, soldiers' wounds were treated with honey. Consuming honey from stingless bees has been used to treat coughs, glaucoma, cataracts, and the flu. Even now, honey is still a widely used medicinal ingredient. A New Zealand hospital was using "manuka honey" to treat methicillin-resistant *S. aureus* (MRSA) and other microbial infections, according to a 2007 Manchester Evening News article, several scientific research have proven honey's antimicrobial qualities in recent years (Khan et al., 2014). Keeping in view the medicinal properties of honey, this study was conducted to systematically review the existing literature, highlighting the efficacy of honey in treating various ailments. This review explains the mechanism behind the bioactive compounds of honey and promotes its use in modern clinical practice to boost therapeutic outcomes.

Medicinal Value of Honey

Some of the earliest medical manuscripts provide ample documentation of the therapeutic benefits of honey. Honey's wound healing and antimicrobial properties have long been known. According to Edo et al. (2023), its antibacterial activity, ability to retain a moist wound environment, and high thickness all added to its healing properties by forming a blockade that keeps infections out. Moreover, honey's immune-suppressive properties promote wound healing (Umogbai et al., 2022; Larsen, 2022). The Hydrogen peroxide (H_2O_2) produced by specific enzymatic activity is the primary source of the antibacterial activity of most honeys. Strong antibacterial qualities are retained by manuka honey, which is non-peroxide honey, even after eliminating hydrogen peroxide activity. Its antibacterial properties include a high sugar content and low pH microenvironment of the wound, ultimately preventing microbial growth (Yupanqui et al., 2022). Studies have shown that honey has potent antibacterial properties that are effective against at least sixty (60) different types of bacteria strains (Khan et al., 2014). Unlike antibiotics, which are resistant to certain strains of bacteria, honey is both practical and safe. The benefits of honey have been praised by numerous religious traditions and documented in ancient scriptures. Honey contains essential minerals including magnesium, calcium, potassium, chlorine, sodium, iron, sulphur and phosphate (Tafere, 2021; Hasam et al., 2020). It also contains different types of vitamins depending on the type and quality of pollen and nectar (Basa et al., 2016; Denisow et al., 2016). Its pH ranges typically from 3.2-4.5 depending on climatic conditions, which is acidic enough to hinder the growth of many bacteria. It is predominantly a saturated combination of two monosaccharides with minimal water activity. Most water molecules in honey are bonded to carbohydrates, leaving few for microbes to grow, resulting in an unfavorable environment. However, combining water with honey increases its water activity and reduces its antibacterial capabilities (Khan et al., 2014).

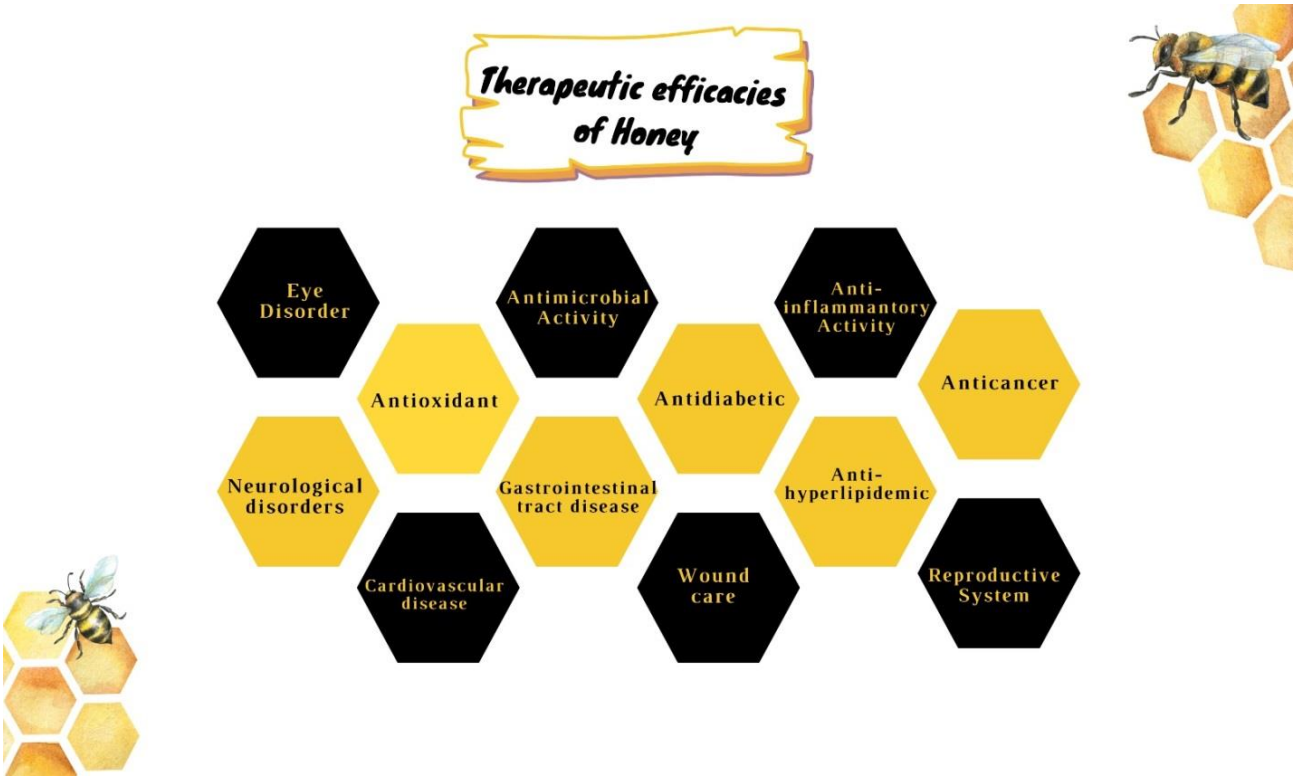

Figure1: Multiple therapeutic attributes of honey: an overview.

Antimicrobial Activity

Various studies concluded that honey has different antimicrobial (antibacterial and antifungal) properties because of hyderogen peroxide, low pH, and water-absorbing properties, while it also boosts immunity during viral infection (Abolhassani et al*.,* 2022). Its high-water absorption property inhibits the development of most of the bacteria's strains, moulds and fungi. When used topically for injuries, the osmotic effect sucks water of liquid materials from the wound into the honey, which helps dry the affected tissue; hence it ultimately limits bacterial development (Yupanqui et al*.,* 2022). Even when diluted with wound water, honey is likely to have a low water activity that constrains the growth of most bacterial strains. One bacterium, *Staphylococcus aureus*, may only be able to grow when the water activity is more than 0.86.

While it can survive in concentrated sugar solutions, it is delicate to the additional antibacterial mechanisms present in honey at the same water activity level (Khan et al., 2014). Honey's antibacterial characteristics make it a common choice for wound treatment in modern medicine (Ismail et al., 2015). When it comes to bacterial illnesses resistant to antibiotics, various types of honey have antibacterial activity to those bacteria (Majtan et al*.,* 2021). The kind and strength of the honey's antibacterial activity depends on its floral sources and are subject to regional variations in climate and temperature (Meo et al., 2017).

Antibacterial Activity of Honey

Honey has been the laboratory and clinical research topic for modern medicine development in recent decades. Van Ketel (1892) first documented honey's antimicrobial viz antibacterial and antifungal properties (Harakeh et al*.,* 2022) and is well known as a key finding. Almasaudi (2021) discovered that honey has clinical promise because of its broad spectrum of antibacterial action, implying possible medicinal applications. This antibacterial effect is primarily due to hydrogen peroxide (H_2O_2), which is formed by the enzyme (glucose oxidase) obtained from honeybees (Bang *et al.,* 2003). Honey's antibacterial effectiveness relies on both peroxide and non-peroxide processes. According to Almasaudi (2021) honey's antimicrobial properties are the outcome of both these activities and there is proof of honey's broad-spectrum antibacterial activity against different strains of Gram-positive and Gram-negative bacteria. Four major components contribute to honey's antimicrobial effects. First, honey's propensity to extract moisture from its surroundings dehydrates microorganisms. Second, honey's high sugar content reduces microbial development, albeit this is not the primary explanation for its antibacterial qualities. Third, honey's acidity, which ranges from 3.2 to 4.5, is sufficient to hinder the development of most microbes. Hydrogen peroxide (H_2O_2) is an essential antibacterial component created by the glucose oxidase, transforming glucose into gluconic acid and hydrogen peroxide. However,

heat and catalase can rapidly remove this peroxide activity. In such circumstances, non-hydrogen peroxide components such as methylglyoxal (MGO) and methyl syringate enhanced honey's particular antibacterial effect (Basa et al., 2016). Around 60 different species of bacteria, including both aerobes and anaerobes bacterial strains, have been demonstrated to be suppressed by honey (Eteraf-Oskouei, and Najafi, 2013; Olaitan et al*.,* 2007). Pathogens sensitive to honey's antibacterial properties include *C. diphtheriae, B. anthracis, H. influenzae, L. monocytogenes, M. tuberculosis, K. pneumonia, P. multocida, P. species, Y. enterocolitica, S. aureus, S. mutans, S. faecalis, S. pneumoniae, P. aeruginosa, V. cholera, S. pyogenes, A. species, S. typhi, S. marcescens*, *S. diarrhea* and *S. dysenteriae* (Asare, 2020; French et al*.,* 2005).

Effect of Honey on Cardiovascular Diseases

Ischemic heart disease (IHD) is a prominent reason for death, disability, and economic burden in affluent nations. Myocardial infarction and Arrhythmias are two severe symptoms of IHD (Ahmed et al*.,* 2014). Ventricular arrhythmias, viz. ventricular tachycardia and ventricular fibrillation are common causes of death during cardiac surgery and MI. Drug therapy, especially anti-arrhythmic medications, can be life-saving in the treatment of specific disorders. However, the risk of deadly arrhythmias in some individuals has limited their usage, driving a quest for alternatives with fewer side effects and higher efficacy (Wessler and Kirtane, 2013). Natural honey, which has been used medicinally since ancient times, is a potential alternative (Chepulis, 2007; Afroz et al., 2016). Honey includes numerous phenolic chemicals that have shown promise in treating cardiovascular disorders (Olas, 2020). Phenolic chemicals have anti-ischemic, antithrombotic, vasorelaxant and antioxidant activities in coronary heart disease (CHD) (Mahesar et al., 2024). Flavonoids, primarily, are known to reduce the risk of CHD through three key actions: increasing coronary vasodilation, decreasing platelet aggregation and avoiding the oxidation of low-density lipoproteins (LDLs) (Bahrami et al*.,* 2008; Basa et al., 2016).

Biological Bioactive Compounds

Honey contains a wide range of important bioactive beneficial compounds, including vitamins such as Thiamine, Tocopherol, Retinol, Vitamin K (Anti-Haemorrhagic Vitamin), Niacin, Riboflavin, Ascorbic acid, Vitamin B6, and Pantothenic acid, as well as fatty acids, phenolics, and flavonoids. It also contains hydroxybenzoic acid, ethyl ester, octadecanoic acid, cinnamic acid and beneficial flavonoids (Muhammad et al*.,* 2016). Additionally, honey contains bioactive compounds such as pinocembrin, apigenin, acacetin, ferulic acid, and abscisic acid (Margaoan et al., 2021). Furthermore, honey contains physiologically essential amino acids, viz. cysteine, glutamic acid, arginine, protein, and aspartic acid (Rather et al., 2020). Honey's composition contains various phenolics, flavonoids, ascorbic acid, amino acids, carotenoids, and proteins and its antioxidant and antibacterial characteristics vary depending on the climatic conditions (Sulaiman and Sarbon, 2022). The addition of these powerful substances advances our comprehension of the possible biological roles played by honey (Bobis et al., 2021).

Honey in Cough Management

Cough is a significant problem for people of all ages, and it is one of the most prevalent ailments seen by general practitioners (Morice et al*.,* 2020; Paul et al*.,* 2007). Cough in children is frequently connected with a variety of etiological and pathogenic factors that differ depending on age, geography, environment, weather, and epidemiological conditions. The causes and effects of cough in the pediatric population differ from those of young adults (Al-Juaid et al*.,* 2018). Children's undeveloped immune systems make them more susceptible to infections that can cause prolonged or chronic coughing, exacerbating the adverse effects of cough (Ahmad et al., 2017). Research on the causes and treatments of childhood cough has recently increased since it is critical to the long-term respiratory health of these youngsters. There is a chance that many drugs used to treat children's coughs could have adverse effects, including sleepiness (Yust and Slattery, 2012). However, honey has been demonstrated to be an even more efficient treatment for cough frequency, with reports of a significant reduction in clinical symptoms (Abuelgasim et al., 2021).

Research by Cohen et al*.* (2012) involved 300 children between the ages of one to five who had nocturnal coughs, upper respiratory tract infections and illnesses that lasted a week. The effects of a single evening dose of three different kinds of honey (labiatae, citrus, and eucalyptus) on coughing were compared. The manuscripts revealed that the effect of all three honey groups on cough symptoms had improved considerably more than those of the placebo group. Parents gave honey products higher ratings than the silan date extract, pointing out that honey helped children with upper respiratory infections sleep better and relieve nighttime cough symptoms more effectively.

Antioxidant Properties of Honey

Free radicals are created during the biochemical process of oxidation, which can set off events that injure cells and tissues and eventually interfere with physiological processes. Vitamin C and other antioxidants are essential for

stopping these chain reactions and shielding the body from the destructive properties of free radicals. A complex system of overlapping antioxidants is necessary for the human body to maintain a balanced oxidative state. Antioxidant-rich foods have been demonstrated to improve health, and honey is known for having strong antioxidant qualities. The concentration and place of origin of honey can affect its effectiveness as an antioxidant. Honey, being an antioxidant, has several preventive qualities against a range of clinical ailments, such as cancer, ageing, neurodegeneration, coronary artery diseases, and inflammatory disorders (Al-Kafaween et al*.,* 2023).

Honey has a higher concentration of phenolic chemicals, which enhances its antioxidant potential (Kishore et al., 2011). Climate and geography affect the kinds of antioxidants present in honey, including phenolic acids and polyphenols. For example, sunflower honey contains quercetin, but rosemary honey contains the flavanol kaempferol (Kaur et al*.,* 2017).

Honey and Glycemic Index

There is constant discussion over the effects of carbohydrate consumption on human health, especially concerning how various carbohydrate diets alter blood glucose levels (Ojo et al*.,* 2018). Currently, the glycaemic index (GI), which classifies carbohydrates according to their impact on blood glucose, is frequently used to assess the relevance of carbohydrates (Zafar et al*.,* 2019). Blood glucose rises more gradually with low-GI carbohydrates and more quickly with high-GI carbohydrates. Different varieties of honey, especially those with only one flower, are known to have variable fructose levels and fructose-to-glucose ratios (Se et al*.,* 2019). For instance, Acacia and citrus honeys have a higher proportion of fructose, resulting in a lower GI. The GI theory aids in forecasting how carbohydrates may affect health, especially concerning endocrine and metabolic problems (Bogdanov, 2012). Honeys with a low GI are usually preferable to those with a high GI. Low-GI carbohydrate diets have been demonstrated to have several metabolic advantages, especially for those with coronary artery disease and diabetes mellitus (Chiavaroli et al*.,* 2016). Al-Waili (2013) suggests that patients with compromised endocrine function may benefit from consuming low GI honey, such as acacia honey, as it may provide physiological benefits. That being said, there is still debate over the usage of honey by people with diabetes (Meo et al*.,* 2017).

Honey and Fertility

Honey has a long history of being connected to fertility, as the ancient Egyptians used it to boost fertility. Honey has long been used in many cultures to promote vitality, especially in men. Numerous factors can contribute to infertility, and honey's abundance of amino acids, iron, vitamins, calcium, and immune-stimulating qualities is thought to provide viable treatments. Honey and bee pollen have been linked in numerous studies to increased fecundity, general fertility, and egg quality (Zaid et al., 2021).

Both men with impotence and women with infertility problems, including irregular ovulation, have been advised to use honey (Hajam et al*.,* 2020). It is believed that drinking honey along with warm milk will dramatically improve sperm count in subfertile men. A favourable link has been seen between the ingestion of honey and testosterone levels, possibly due to the vitamin B content of honey, which is crucial for the creation of testosterone. Because honey has a high nitric oxide level, which is crucial for vasodilation, it may aid with erectile dysfunction. Studies show that ingesting 100 grams of honey can increase blood levels of nitric oxide by as much as 50% (Meo et al*.,* 2017).

Practitioners of complementary and alternative medicine claim that honey boosts women's ovaries and uterus and improves the quality of sperm in males. According to recent research, sperm quality can be increased overall by mixing honey into cryoprotectant solutions (Fakhrildin and Alsaadi, 2014). In studies involving male rabbits, those given bee pollen showed enhanced semen quality and fertility, while in the case of young bunnies, they also gained weight and had greater survival rates. Furthermore, research has shown that applying royal jelly and bee honey vaginally around the time of sexual activity can improve reproductive results for couples who are having difficulty conceiving naturally (Abdelhafiz and Muhamad, 2008).

Honey in Wound Healing

Historical scientific literature has provided ample evidence of the beneficial value of honey. Its antibacterial activity, capacity to keep the site moist, and high viscosity, which form an impenetrable barrier against infections, are principally responsible for its healing qualities (Mandal and Mandal, 2011; Hananeh et al., 2015). Honey has been shown to have several advantageous benefits on wounds and a positive significant effect on wound healing (Scepankove et al*.,* 2021; Jull et al*.*, 2015). It assists the growth of healing and increases blood circulation to help a fast-healing process. According to research, honey is especially popular for burn wounds (Pasupuleti et al*.,* 2017). It has shown promise for treating various wounds, notably when other therapeutic approaches have failed (Kaur et al., 2017). Furthermore, honey helps to reduce the chance of wound contamination (Alfarisi et al., 2021; Wilkinson et al., 2011).

Honey and Gastric Ulcers

The stomach lining's mucosa breaks down in gastric ulcers, which are larger than 5 mm in diameter and extend through the muscularis mucosa. Changes in the gastric mucosa can lead to erosion and, ultimately, ulceration when the stomach's defence mechanisms are compromised (Woolf, 2023). In one investigation, acetylsalicylic acid at a concentration of 50 mg/kg body weight was used to produce stomach ulcers in 60 rats. Each rat was given 0.5 ml of floral honey made from bees fed on sugar or saline for three days in a row, 24 hours after the injection. This dosage is equated to about 4 grammes per kilogramme of body weight. After treatment, the rats were slaughtered, and the quantity of stomach ulcers was counted. The findings showed that just 47% of the rats given sugar honey were classed as healed compared to 80% of the rats given floral honey. However, this study had significant limitations, including a lack of detail regarding the impact of honey consumption on overall food intake, an unclear definition of "healed," and insufficient data reporting, such as only reporting the number of ulcers rather than their sizes (Khan et al., 2014). The efficacy of honey for gastric ulcers is based on its antioxidant and cytoprotective activities. Fazalda et al., 2018 conducted studies on different doses and types of honey on rats and found significant results against gastric ulcers. Subsequent investigations should be carried out to determine the suitable dosage at which humans can attain analogous gastroprotective outcomes.

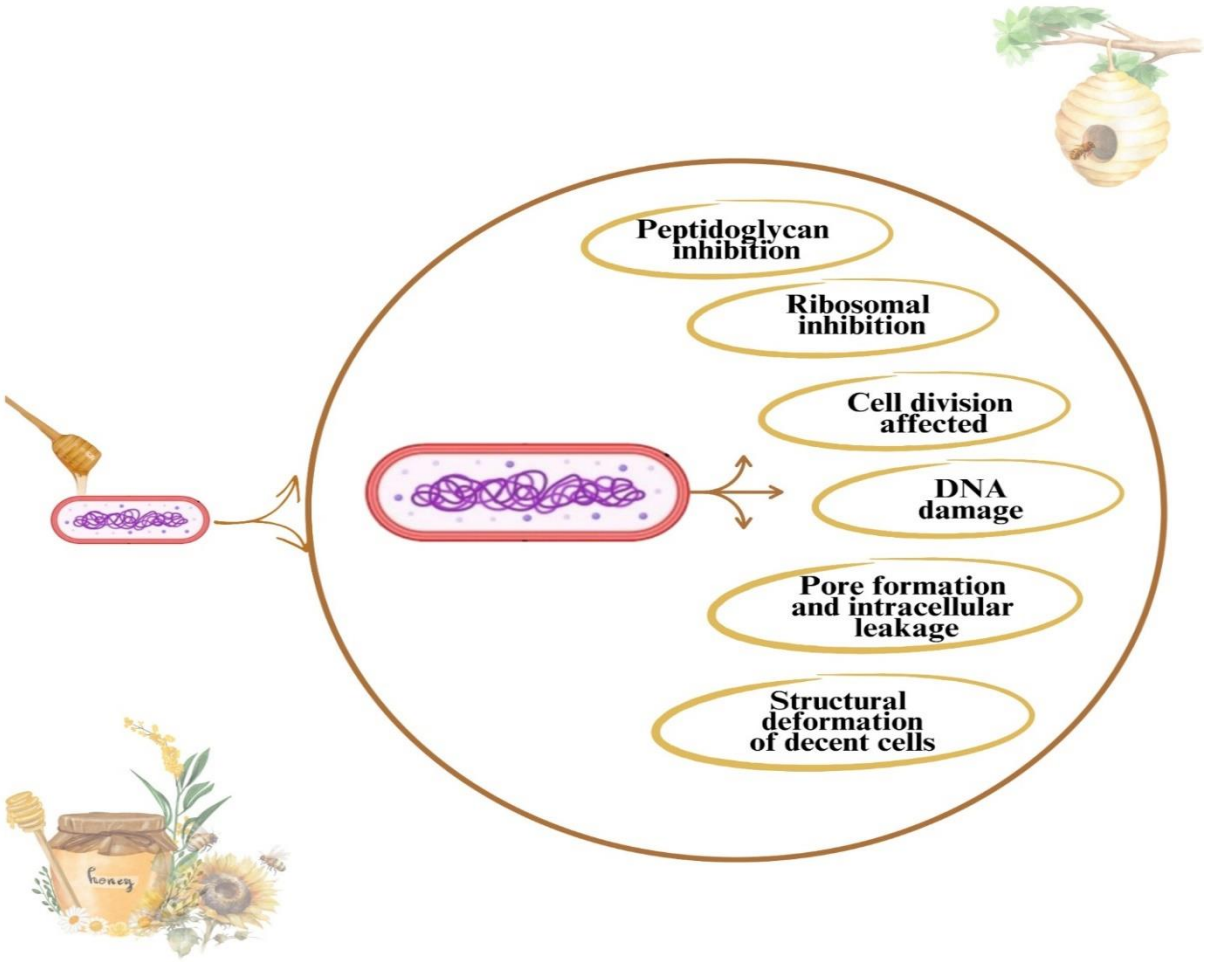

Figure 2: The mechanism by which honey can enhance the medical outfit of the consumer.

FUTURE RESEARCH GUIDELINES AND CONSIDERATIONS

Future study on honey should emphasis on addressing specific gaps, such as the need for demanding clinical trials to authenticate its therapeutic effects and research on the biochemical mechanisms behind its benefits. Moreover, studies should consider the long-term use of honey and regional differences. While honey provides substantial health benefits, as well as wound healing and cough management, potential risks such as effects on allergic reactions, metabolic disorders and contraindications for newborns must also be discussed.

REFRENCES

Abdelhafiz, A. T., & Muhamad, J. A. (2008). Midcycle pericoital intravaginal bee honey and royal jelly for male factor infertility. *International Journal of Gynecology and Obstetrics*, *101*(2), 146-149.

Abolhassani, S., Alipour, H., Alizadeh, A., Nemati, M. M., Najafi, H., & Alavi, O. (2022). Antibacterial effect of electrospun polyurethane-gelatin loaded with honey and ZnO nanoparticles as potential wound dressing. *Journal of Industrial Textiles*, 51(1), 954S-968S.

Abuelgasim, H., Albury, C., & Lee, J. (2021). Effectiveness of honey for symptomatic relief in upper respiratory tract infections: a systematic review and meta-analysis. *BMJ Evidence-Based Medicine*, 26(2), 57-64.

Afroz, R., Tanvir, E., & Little, P. J. (2016). Honey-derived flavonoids: natural products for the prevention of atherosclerosis and cardiovascular diseases. *Clinical and Experimental Pharmacology*, 6(3).

Ahmad, R. S., Hussain, M. B., Saeed, F., Waheed, M., & Tufail, T. (2017). Phytochemistry, metabolism, and ethnomedical scenario of honey: A concurrent review. *International Journal of Food Properties*, 20(1), 254-269.

Ahmed, N., Kazmi, S., Nawaz, H., Javed, M., Anwar, S. A., & Alam, M. A. (2014). Frequency of diabetes mellitus in patients with acute coronary syndrome. *Journal of Ayub Medical College, Abbottabad*, 26(1), 57-60

Alfarisi, H. A. H., Ibrahim, M. B., Mohamed, Z. B. H., Hamdan, A. H. B., & Mohamad, C. A. C. (2021). Honey and its Role in Medical Disorders *Bulletin of Environment*, *Pharmacology* and *Life Sciences,* 10, 250-256.

Al-Juaid, H., AlJuaid, A., Abuharba, W., & Abouhamda, A. (2018). Effect of honey on nocturnal cough among children in Taif city. *International Journal of Community Medicine and Public Health*, 5(3), 922.

Al-Kafaween, M. A., Alwahsh, M., Mohd Hilmi, A. B. & Abulebdah, D. H. (2023). Physicochemical characteristics and bioactive compounds of different types of honey and their biological and therapeutic properties: a comprehensive review. *Antibiotics*, 12(2), 337.

Almasaudi, S. (2021). The antibacterial activities of honey. *Saudi journal of biological sciences*, 28(4), 2188-2196.

Al-Waili, N., Salom, K., Al-Ghamdi, A., Ansari, M. J., Al-Waili, A., & Al-Waili, T. (2013). Honey and cardiovascular risk factors, in normal individuals and in patients with diabetes mellitus or dyslipidemia. *Journal of Medicinal Food*, 16(12), 1063-1078.

Asare, F. (2020). Honey as a therapeutic agent, an insight into its antimicrobial properties. *Science Open Preprints*.

Aziz, M. A. (Ed.). (2024). Melittology New Advances. Intech Open. doi: 10.5772/intechopen.104314.

Bahrami, M., Ataie-Jafari, A., Hosseini, S., Forouzanfar, M., Rahmani, M., & Pajouhi, M., (2008). Effects of natural honey consumption in diabetic patients: an 8-week randomized clinical trial. *International Journal of Food Science and Nutrition*, 2, 1-9.

Basa, B., Belay, W., Tilahun, A., & Teshale, A. (2016). Review on medicinal value of honeybee products: Apitherapy. *Advances in Biological Research*, 10(4), 236-247.

Bobiş, O., Bonta, V., Cornea-Cipcigan, M., Nayik, G. A., & Dezmirean, D. S. (2021). Bioactive molecules for discriminating Robinia and helianthus honey: High-performance liquid chromatography–electron spray ionization–mass spectrometry polyphenolic profile and physicochemical determinations. *Molecules*, 26(15), 4433.

Bogdanov, S. (2012). Honey as nutrient and functional food. *Proteins*, 1100, 1400-2700.

Cannas, M., Fadda, C., Urgeghe, P. P., Piga, A., & Conte, P. (2024). Honey as a Sugar Substitute in Gluten-Free Bread Production. *Foods*, 13(18), 2973.

Çelik, K., & Aşgun, H. F. (2020). Apitherapy: Health and healing from the bees. *Tudás Alapítvány.*

Chepulis, L. M., (2007). The effect of honey compared to sucrose, mixed sugars and a sugar-free diet on weight gain in young rats. *Journal of Food Science*, 72, 5224-5229.

Chiavaroli, L., Mirrahimi, A., Ireland, C., Mitchell, S., Sahye-Pudaruth, S., Coveney, J., Olowoyeye, O., Maraj, T., Patel, D., de Souza, R.J. & Jenkins, D. J. (2016). Low-glycaemic index diet to improve glycaemic control and cardiovascular disease in type 2 diabetes: design and methods for a randomised, controlled, clinical trial. *BMJ open*, 6(7), e012220.

Cohen, H. A., Rozen, J., Kristal, H., Laks, Y., Berkovitch, M., Uziel, Y., Kozer, E., Pomeranz, A., & Efrat, H. (2012). Effect of honey on nocturnal cough and sleep quality: a double-blind, randomized, placebo-controlled study. *Pediatrics*, 130(3), 465-471.

Denisow, B., & Denisow P. M. (2016). Biological and therapeutic properties of bee pollen: A review. *Journal of the Science of Food and Agriculture*, *96*(13), 4303-4309.

Edo, G. I., Onoharigho, F. O., Akpoghelie, P. O., Akpoghelie, E. O., Agbo, J. J., Agoh, E., & Lawal, R. A. (2023). Natural honey (raw honey): insights on quality, composition, economic and health effects: a comprehensive review*. Food Science and Engineering*, 265-293.

Eteraf-Oskouei, T., & Najafi, M. (2013). Traditional and modern uses of natural honey in human diseases: a review. *Iranian Journal of Basic Medical Sciences*, 16(6), 731.

Fakhrildin, M. B. M., & Alsaadi, R. A. (2014). Honey Supplementation to semen-freezing medium improves human sperm parameters post-thawing. *Journal of Family & Reproductive Health,* 8(1), 27.

Fazalda, A., Quraisiah, A., & Nur Azlina, M. F. (2018). Antiulcer Effect of Honey in Nonsteroidal Anti-Inflammatory Drugs Induced Gastric Ulcer Model in Rats: A Systematic Review. *Evidence-Based Complementary and Alternative Medicine*. *eCAM*, *2018*, 7515692. https://doi.org/10.1155/2018/7515692

French. V. M., Cooper. R. A., & Molan. P. C. (2005). The antibacterial activity of honey against coagulase-negative staphylococci. *Journal of Antimicrobial Chemotherapy*, 56,228-231.

Gibbs, Diana, Muirhead, & Ian, F., (2008). The economic value and environmental impact of the Australian beekeeping industry, a report prepared for Australian beekeeping industry, *Journal of the American College of Nutrition.,* 27(6), 677-689.

Hajam, Y. A., Neelam, Basheer, M., Kumar, R., & Devi, A. (2024). Physiological and Curative Role of Honey to Reduce Pathogenesis of Reproductive Disorders. *Honey in Food Science and Physiology*, 411-438.

Hananeh, W. M., Ismail, Z. B., Alshehabat, M. A., & Abeeleh, M. A. (2015). Effects of Sidr honey on second-intention healing of contaminated full-thickness skin wounds in healthy dogs. *Journal of Veterinary Research*, *59*(3), 433-439.

Harakeh, S., Saber, S. H., Akefe, I. O., Shaker, S., Hussain, M. B., Almasaudi, A. S., & Almasaudi, S. (2022). Saudi honey alleviates indomethacin-induced gastric ulcer via improving antioxidant and anti-inflammatory responses in male albino rats. *Saudi Journal of Biological Sciences*, 29(4), 3040-3050.

Hasam, S., Qarizada, D., & Azizi, M. (2020). A review: honey and its nutritional composition. *Asian Journal of Research in Biochemistry*, 7(3), 34-43.

Hashim, F. H., & Abdullah, W. N. W. (2017). Swarm Intelligence: From the Perspective of Al-Quran and Al-Sunnah to Natural and Artificial Systems. *Advanced Science Letters*, 23(5), 4580-4585.

Iftikhar, A., Nausheen, R., Mukhtar, I., Iqbal, R. K., Raza, A., Yasin, A., & Anwar, H. (2023). The regenerative potential of honey: A comprehensive literature review. *Journal of Apicultural Research*, 62(1), 97-112.

Ismail, Z. B., Alshehabat, M. A., Hananeh, W., Daradka, M., Ali, J. F. H., & El-Najjar, E. K. (2015). Recent advances in topical wound healing products with special reference to honey: a review. *Research Opinions in Animal and Veterinary Sciences*, *5*(2), 76-83.

Jull, A. B., Cullum, N., Dumville, J. C., Westby, M. J., Deshpande, S., & Walker, N. (2015). Honey as a topical treatment for wounds. *Cochrane Database of Systematic Reviews*, (3).

Kaur, S., Mirza, A., & Singh, J. (2017). Recent advances of honey in modern medicines: A review. *Journal of Pharmacognosy and Phytochemistry*, *6*(4), 2063-2067.

Khan, I. U., Dubey, W., & Gupta, V. (2014). Medicinal properties of honey: A review. *International Journal of Pure Applied Bioscience*, 2(5), 149-156.

Kishore, R. K., Halim, A. S., Syazana, M. N., & Sirajudeen, K. N. S. (2011). Tualang honey has higher phenolic content and greater radical scavenging activity compared with other honey sources. *Nutrition Research*, *31*(4), 322-325.

Kratz, M. (2022). The effects of nutrition on honey bee (*Apis mellifera*) health and colony performance during crop pollination.

Larsen, P. M. (2022). Evaluation of longevity, antibacterial, antioxidant and antiinflammatory efficacies of honey extracted from lozenges.

Liyanage, D., & Mawatha, B., (2017). Health benefits and traditional uses of honey: A review. *Journal of Apitherapy*, 2(1), 9-14.

Mahesar, S. A., Sidhu, A. R., Naz, S., & Kandhro, A. A. (2024). Phenolic and mineral contents in honey and their associated health benefits. In Honey in Food Science and Physiology (pp. 155-179). Singapore: Springer Nature Singapore.

Majtan, J., Bucekova, M., Kafantaris, I., Szweda, P., Hammer, K., & Mossialos, D. (2021). Honey antibacterial activity: A neglected aspect of honey quality assurance as functional food. *Trends in Food Science & Technology*, 118, 870-886.

Mandal, M. D., & Mandal, S. (2011). Honey: its medicinal property and antibacterial activity. *Asian Pacific Journal of Tropical Biomedicine*, 1(2), 154-160.

Mărgăoan, R., Topal, E., Balkanska, R., Yücel, B., Oravecz, T., Cornea-Cipcigan, M., & Vodnar, D. C. (2021). Monofloral honeys as a potential source of natural antioxidants, minerals and medicine. *Antioxidants*, 10(7), 1023.

Meo, S. A., Al-Asiri, S. A., Mahesar, A. L., & Ansari, M. J. (2017). Role of honey in modern medicine. *Saudi Journal of Biological Sciences*, *24*(5), 975-978.

Morice, A. H., Millqvist, E., Bieksiene, K., Birring, S. S., Dicpinigaitis, P., Ribas, C. D., Boon, M. H., Kantar, A., Lai, K., McGarvey, L., Rigau, D. & Zacharasiewicz, A. (2020). ERS guidelines on the diagnosis and treatment of chronic cough in adults and children. *European Respiratory Journal*, 55(1).

Muhammad, A., Odunola, O. A., Ibrahim, M. A., Sallau, A. B., Erukainure, O. L., Aimola, I. A., & Malami, I. (2016). Potential biological activity of acacia honey. *Frontiers in Bioscience-Elite*, *8*(2), 351-357.

Ojo, O., Ojo, O. O., Adebowale, F., & Wang, X. H. (2018) The effect of dietary glycaemic index on glycaemia in patients with type 2 diabetes: a systematic review and meta-analysis of randomized controlled trials. *Nutrients*, 10(3),373.

Olaitan, P. B., Adeleke, E. O., & Ola, O. I. (2007). Honey: a reservoir for microorganisms and an inhibitory agent for microbes. *African Health Sciences*., 7, 159-160.

Olas, B. (2020). Honey and its phenolic compounds as an effective natural medicine for cardiovascular diseases in humans. *Nutrients*, 12(2), 283.

Pasupuleti, V. R., Sammugam, L., Ramesh, N., & Gan, S. H. (2017). Honey, propolis, and royal jelly: a comprehensive review of their biological actions and health benefits. *Oxidative Medicine and Cellular Longevity*, 2017(1), 1259510.

Paul. I. M., Beiler. J., McMonagle. A., Shaffer. M. L., Duda. L., & Berlin. C. M., Jr. (2007). Effect of honey, dextromethorphan, and no treatment on nocturnal cough and sleep quality for coughing children and their parents. *Archives of Pediatrics & Adolescent Medicine*, 161 (12), 1140-6.

Rather, M. A., Bashir, S. M., Mumtaz, P. T., Amin, I., & Ali, A. (2020). Recent Advances in the Discovery of Bioactive Components from Natural Honey. *Therapeutic Applications of Honey and its Phytochemicals,* Vol. 1, 171-191.

Reddy, N. B., Lakshmi N., Sunitha, A. N. V., Bhagya, R., Jyothi, B., Chaitanya and Sharma, J. V. C.)2019). A review on nutraceuticals. *Journal of Pharmacognosy and Phytochemistry*, 8(4), 735-744.

Salama, Y., & Chennaoui M. (2024) Biochemical Properties and Therapeutic Activities of Honey: A Review. *Journal of Materials and Environmental Science,* 15 (2), 301, 324.

Saulawa, U. A., & Hamisu, S.L. (2018). Evaluation of synergistic activity of black seed extract (Nigella sativa), honey and Zamzam water on candida albicans. *UMYU Journal of Microbiology Research*, 3(2), 116-122.

Scepankova, H., Combarros-Fuertes, P., Fresno, J. M., Tornadijo, M. E., Dias, M. S., Pinto, C. A., & Estevinho, L. M. (2021). Role of honey in advanced wound care. *Molecules*, 26(16), 4784.

Se, K. W., Wahab, R. A., Yaacob, S. N. S., & Ghoshal, S. K. (2019). Detection techniques for adulterants in honey: Challenges and recent trends. *Journal of Food Composition and Analysis*, 80, 16-32.

Sharma, S., Chauhan, A., & Okeke, E. S. (2024). Honey as Potential Cosmeceutical Agent and Functional Food. In Honey in Food Science and Physiology (pp. 57-87). Singapore: Springer Nature Singapore.

Sulaiman, N. H. I., & Sarbon, N. M. (2022). Physicochemical, antioxidant and antimicrobial properties of selected Malaysian honey as treated at different temperature: A comparative study. *Journal of Apicultural Research*, 61(4), 567-575.

Tafere, D. A. (2021). Chemical composition and uses of Honey: A review. *Journal of Food Science and Nutrition Research,* 4(3), 194-201.

Umogbai, O. O., Ogli, S. A., Agaba, E. I., & Yongo, M. A. (2022). Natural honey pre-treatment protects against immune suppression in cyclophospamide exposed wistar rats. *Highland Medical Research Journal*, 22(1), 20-26.

Wenli, S., Shahrajabian, M. H., & Qi, C. (2021). Health benefits of wolfberry (Gou Qi Zi, *Fructus barbarum* L.) on the basis of ancient Chinese herbalism and Western modern medicine. *Avicenna Journal of Phytomedicine*, 11(2), 109.

Wessler, J. D., & Kirtane, A. J. (2013). Patients who require non-cardiac surgery in acute coronary syndrome. *Current Cardiology Reports*, 15(7), 373.

Wilkinson, L. J., White, R. J., & Chipman, J. K. (2011). Silver and nanoparticles of silver in wound dressings: a review of efficacy and safety. *Journal of Wound Care*, 20(11), 543-549.

Woolf, A., & Rose, R. (2024). Gastric Ulcer. [Updated 2023 Nov 3]. In: Stat Pearls [Internet]. Treasure Island (FL): Stat Pearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK537128/

Yupanqui M. J., Vyas, C., Aslan, E., Humphreys, G., Diver, C., & Bartolo, P. (2022). Honey: An advanced antimicrobial and wound healing biomaterial for tissue engineering applications. *Pharmaceutics*, 14(8), 1663.

Yust, E., & Slattery, A. (2012). Cold and cough medications for children: dangerous and over the counter. *Clinical Pediatric Emergency Medicine*, 13(4), 292-299.

Zafar, M. I., Mills, K. E., Zheng, J., Peng, M. M., Ye, X., & Chen, L. L. (2019). Low glycaemic index diets as an intervention for obesity: a systematic review and meta-analysis. *Obesity Reviews*, 2019, 20(2), 290-315.

Zaid, S. S. M., Ruslee, S. S., & Mokhtar, M. H. (2021). Protective roles of honey in reproductive health: a review. *Molecules*, 26(11), 3322.

Zainol, M. I., Yusoff, M. K., & Yusof, M. Y. (2013). Antibacterial activity of selected Malaysian honey. *BMC Complementary and Alternative Medicine*, 13, 1-10.