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Medicinal Value of Honeybee Products: A Scientific Review

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In addition to being vital for pollination and agricultural sustainability, honeybees (*Apis spp.*) also produce a variety of bioactive compounds with important therapeutic uses. Honey, bee pollen, propolis, royal jelly, and beeswax are known to have pharmacological properties such as antibacterial, anti-inflammatory, antioxidant, antiviral, anticancer, and immunomodulatory effects. Based on current research and clinical applications, this review offers a thorough scientific overview of these bee products' therapeutic potential.

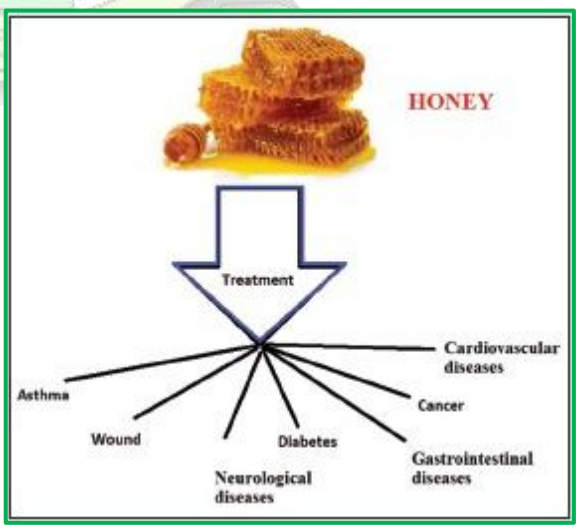
Introduction

Honey bees belong to the genus Apis, which in Latin means "bee, " the prefix "api" is often used in beekeeping terms such as, apiarist, a beekeeper or honey farmer; apiary, the location of bee hives; apiculture, the cultivation or farming of bees; and apitherapy, the use of bee products for health purposes. This social insect lives in a colony of several thousand bees and is in the order Hymenoptera, family *Apidae* and subfamily *Apinae*. For centuries, traditional medicine in many cultures has made use of natural products curated by the bees. These substances' complex chemical makeup and wide range of therapeutic potential have been uncovered by scientific investigation. Because of their rich composition of bioactive compounds, biocompatibility, and relatively low toxicity, honeybee products are currently becoming more and more popular in both conventional and complementary alternative therapeutic medicine.

The medicinal qualities and modes of action of the five main bee products—honey, propolis, pollen, royal jelly, and beeswax—are well discussed in the following.

Honey

Honey is a supersaturated sugar solution composed primarily of glucose and fructose, along with enzymes (e.g., glucose oxidase), amino acids, organic acids, vitamins, and polyphenolic compounds (Bogdanov et al., 2008), which is made from the nectar that is collected by the bees from flowers. Its therapeutic activity is largely attributed to hydrogen peroxide production, low pH, and the presence of phytochemicals such as flavonoids and phenolic acids.



Antimicrobial and Wound Healing Properties

Honey exhibits broad-spectrum antimicrobial

activity against Gram-positive and Gram-negative bacteria, fungi, and viruses (Mandal & Mandal, 2011). Manuka honey, derived from *Leptospermum scoparium*, contains methylglyoxal (MGO), a potent antimicrobial agent (Mavric *et al*., 2008).
Clinical studies show honey's efficacy in promoting wound healing by maintaining a moist environment, stimulating angiogenesis, and reducing inflammation. Honey also accelerates epithelialization and reduces scar formation.

- **Antioxidant and Anti-inflammatory Activity**

The polyphenolic content of honey contributes significantly to its antioxidant capacity, which helps mitigate oxidative stress-related disorders such as cardiovascular disease and neurodegeneration. Additionally, honey suppresses pro-inflammatory cytokines and modulates immune responses.

Propolis

Propolis is a resinous substance collected by bees from tree buds, mixed with wax and bee enzymes. It contains over 300 compounds, including flavonoids (e.g., chrysin, galangin), phenolic acids (e.g., caffeic acid), and terpenoids (Wagh, 2013).

- **Antimicrobial Properties**

Propolis exhibits strong antimicrobial effects, particularly due to the synergy of its polyphenolic components. It inhibits the growth of various pathogens, including *Staphylococcus aureus*, *Helicobacter pylori*, and *Candida albicans* (Sforcin & Bankova, 2011). These properties make it useful in treating respiratory infections, skin diseases, and gastrointestinal disorders.

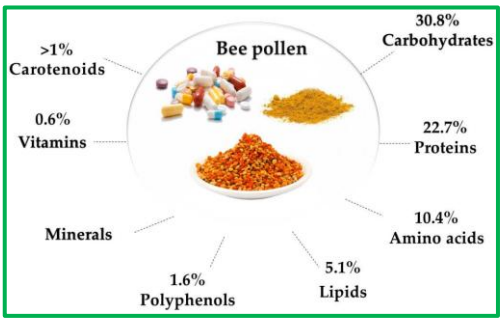
- **Immunomodulatory and Anti-cancer Effects**

Studies have shown that propolis enhances macrophage activity and cytokine production, improving host resistance against infections. Caffeic acid phenethyl ester (CAPE), a major constituent, has demonstrated anti-cancer properties through apoptosis induction and inhibition of angiogenesis and metastasis (Búfalo *et al*., 2013).

Bee Pollen

Nutritional Composition

Bee pollen is a complex mixture of flower pollen, nectar, bee secretions, and enzymes. It contains 20–25% proteins, essential amino acids, vitamins (B-complex, C, E), lipids, flavonoids, and carotenoids (Komosinska-Vassev *et al*., 2015).



- **Pharmacological Properties**

Bee pollen is known for its:

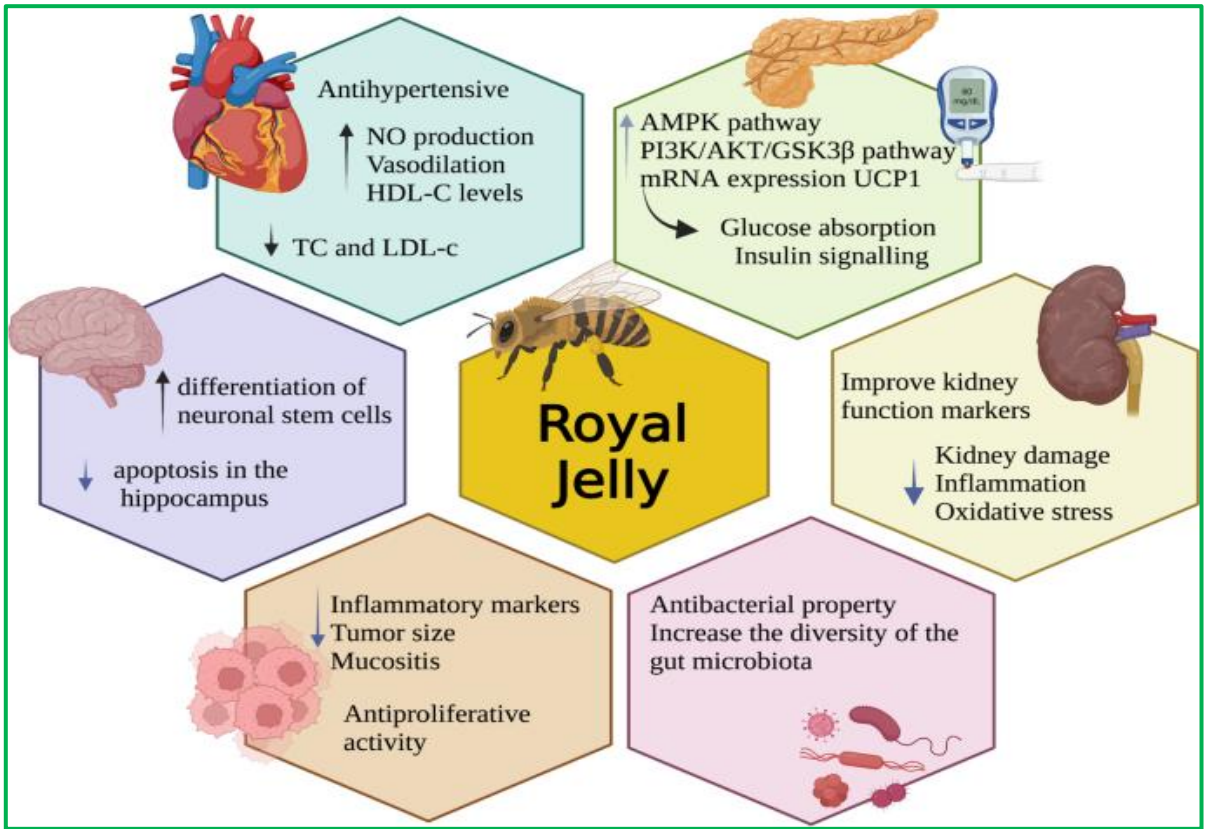
- **Antioxidant properties**: Flavonoids and phenolic compounds neutralize free radicals, protecting cells from oxidative damage.
- **Hepatoprotective effects**: It reduces liver damage and improves hepatic enzyme levels in animal models.
- **Anti-inflammatory and antiallergic potential**: Bee pollen modulates inflammatory markers and reduces histamine release, showing promise in treating allergic diseases.

- **Reproductive Health and Performance Enhancement**

Studies suggest bee pollen can improve fertility in both men and women by enhancing sperm quality and hormonal balance. Its rich nutrient profile makes it a popular supplement among athletes for boosting stamina and recovery.

Royal Jelly

Royal jelly is a secretion from the hypopharyngeal glands of worker bees. It consists of water (60–70%), proteins (12–15%), sugars (10–16%), lipids (3–6%), vitamins (notably B5 and B6), and unique fatty acids like 10-hydroxy-2-decenoic acid (10-HDA) (Li *et al*., 2013).



Biological Activities

Royal jelly is known for its:

- **Antioxidant and neuroprotective effects**: It improves cognitive function and exhibits neurotrophic effects in Alzheimer's models.
- **Hormonal and fertility-enhancing properties**: It modulates estrogenic activity and supports reproductive health in women with menopause or PCOS.
- **Anticancer potential**: 10-HDA induces apoptosis and inhibits cancer cell proliferation in vitro (Sakiyama *et al*., 2012).

Beeswax

Beeswax is composed mainly of esters of fatty acids and alcohols, hydrocarbons, and free acids. While not ingested like other bee products, it is extensively used in pharmaceuticals and cosmetics due to its emollient, anti-inflammatory, and barrier-forming properties.

Medicinal Uses

- Used in topical formulations for eczema, dermatitis, and psoriasis.
- Mixed with propolis and honey in formulations to treat skin infections, burns, and wounds.
- Serves as a drug delivery base in dermatological and dental preparations due to its slow-release properties.

Bee Venom

Honeybee venom is produced by two glands associated with the sting apparatus of worker bees. One is lying in the abdomen, rather long and known as acids gland of the sting producing acid, while the other gland is short, thick and known as alkaline gland. Its production increases during the first two weeks of the adult worker's life and reaches a maximum when the worker bee becomes involved in hive defense and foraging. It diminishes as the bee gets older. The queen bee's production of venom is highest on emergence, probably because it must be prepared for immediate battles with other queens. Bee venom contains 18 biologically active components, including polypeptides, amines, enzymes, amino acids and lipids. Its components, such as Melittin, Apamin, MCD peptide and phospholipase A2 etc; these contain effective biotic and pharmaceutical potentials, including anti-bacterial, anti-

cancer, anti-viral, anti-inflammatory, anti-nociceptive, radioprotective, anti-arthritis, antifungal as well as hepato-protective properties. It also contains histamine that helps in perviousness of blood vessels (Moreno and Giralt, 2015).

Clinical Applications and Safety

Several clinical studies and trials support the safety and efficacy of bee products:

- Honey has been used in diabetic foot ulcers with success in wound healing and infection control.
- Propolis mouthwashes and lozenges have shown efficacy in oral mucositis and gingivitis management.
- Royal jelly supplementation has improved lipid profiles and reduced menopausal symptoms in clinical subjects.

Despite these benefits, individuals with bee allergies must exercise caution. Overdose or contamination of bee products may cause adverse effects. Standardization and quality control remain challenges due to variations in composition based on botanical and geographical sources.

Conclusion

Bee products are potent sources of biologically active compounds that offer a natural alternative or adjunct to modern therapeutic strategies. From antimicrobial and anti-inflammatory to anticancer and immunomodulatory effects, the medicinal value of honeybee products is vast and promising. As research progresses, standardization, safety profiling, and clinical validation will be essential to integrate these natural remedies into mainstream medicine effectively. Given their multifunctional properties, bee products stand as shining examples of nature's pharmacy, deserving further exploration and conservation.

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