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HONEY AND HONEY-BASED PRODUCTS IN THE PRESERVATION OF HUMAN HEALTH

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Abstract. *Honey and bee products—such as propolis, royal jelly, pollen, and beeswax—are a valuable natural resource with numerous health benefits for humans. Due to their rich content of biologically active compounds, including antioxidants, flavonoids, enzymes, amino acids, minerals, and vitamins, honey serves not only as a natural sweetener but also as a functional food with preventive and therapeutic potential. Honey exhibits strong* ***antimicrobial, anti-inflammatory, antioxidant, and immunomodulatory properties****, making it beneficial in the prevention and treatment of infections, wound healing, gastrointestinal disturbances, and respiratory conditions. Propolis, rich in flavonoids and phenolic acids, is effective against bacteria, viruses, and fungi, while royal jelly contributes to metabolic and hormonal balance. Pollen enhances immune function and is used in nutritional rehabilitation. Scientific studies confirm that regular consumption of high-quality honey can improve the* ***lipid profile, glycemic balance, and antioxidant status*** *of the body, particularly in the context of chronic non-communicable diseases such as cardiovascular disorders, diabetes, and cancer. However, its effects depend on botanical origin, quality, and processing methods. Despite its numerous advantages, there is a need to emphasize the importance of* ***quality standardization, prevention of adulteration****, and public education regarding the proper use of bee products. Further clinical research is essential to validate therapeutic efficacy and establish recommended doses for human populations. Honey and bee products represent a vital element of natural prevention and support for human health. Their integration into daily nutrition, under professional guidance and scientific verification, can significantly contribute to public health promotion and the reduction of chronic disease risks.*

Key words: *honey, honey-based products, prevention and therapy, human health*

Introduction

Beekeeping by humans, especially for honey production, dates back around 10,000 years. Beekeeping, or apiculture, is the maintenance of bee colonies in artificially created habitats—hives. From the earliest hives to today's modern designs, beekeeping has evolved over thousands of years, and today we are witnessing changes in equipment and approaches with artificial intelligence offering new possibilities.

The first beekeepers mimicked nature, housing bees in handmade hives from various materials, while honey was harvested using destructive methods. Modern reusable hives provided new possibilities and ensured the survival of bee colonies. Beekeepers or apiculturists, whether small-scale or large-scale, care for their bees, which collect nectar and pollen and process them into honey, wax, propolis, pollen, and royal jelly.

The main role of bees in the ecosystem is pollination, and beyond that, bees produce a wide range of products for themselves and for humans—honey, royal jelly, wax, and propolis—which are not only nutritionally rich but also have medicinal and cosmetic applications.

Honey and bee products have an extremely long tradition of use in food and medicine. In ancient Egypt, honey was used for embalming and wound healing; in ancient Greece, Hippocrates recommended it for many ailments; while in traditional Chinese medicine, honey has been part of recipes for balancing energy and vitality. This millennia-long use attests to the universal value of bee products. Even today, in Africa and Asia, honey is used to treat chronic wounds and injuries.

Modern medicine increasingly recognizes the functional and therapeutic value of honey and bee products. In an era of rising incidence of chronic non-communicable diseases (diabetes, hypertension, cardiovascular disorders), natural sources of bioactive substances that can aid prevention and therapy are increasingly sought after. Honey and its derivatives represent exactly such a resource.

Honey and Bee Products

Honey is a naturally sweet, liquid, viscous, or crystallized product produced by honeybees (*Apis mellifera*) from the nectar of flowering plants or from secretions on living parts of plants, or from excretions of insects of the order Hemiptera that suck plant sap, which bees collect, enrich with their own specific substances, transform, and store in honeycomb cells to mature.

Honey is classified according to the origin of the nectar or honeydew:

1. **Blossom or Nectar Honey** – produced by honeybees from the nectar of various flowering plants (linden, acacia, sage, lavender, etc.):
    - **Unifloral honey** – the proportion of pollen grains from a particular plant species must meet the minimum percentage set by regulations and have the characteristic taste and aroma of the labeled plant.
    - **Multifloral honey** – produced from multiple plant species.
2. **Honeydew Honey** – produced by honeybees from honeydew of coniferous or deciduous plants or from excretions of insects (Hemiptera) living on plant sap, or from secretions on living plant parts.
3. **Mixed Honey** – a mixture of nectar and honeydew honey.

According to production and/or presentation methods, honey can be:

1. Comb honey stored by bees in freshly built comb cells without brood or in foundations built exclusively from beeswax, sold in sealed combs or sections.
2. Chunk honey or cut comb.
3. Drained honey obtained by draining uncapped combs without brood.
4. Extracted honey obtained by centrifuging uncapped combs without brood.
5. Creamed honey produced by accelerated crystallization of extracted honey.
6. Pressed honey obtained by pressing combs without brood, with or without moderate heat not exceeding 45 °C.

7. Filtered honey produced in a way that significantly removes pollen along with foreign organic or inorganic matter.
8. Industrial or processing honey, unsuitable for direct human consumption but used in industry or as an ingredient in processed foods because it may:
    - have an off-flavor or odor,
    - be fermenting or overheated.

Honey mainly consists of different sugars—primarily fructose and glucose—as well as organic acids, enzymes, and small particles introduced during its production. The color of honey ranges from nearly colorless to dark brown. Its consistency may be liquid or viscous, partially or fully crystallized. Its aroma varies but must stem from the original plant source.

When marketed as honey or used in any product intended for consumption, no ingredients—including food additives—may be added to honey. It must be, as far as possible, free of organic and inorganic substances foreign to its composition.

In short, honey contains about 200 different substances, including:

- **Carbohydrates:** fructose (38%), glucose (31%), trace amounts of sucrose and maltose.
- **Organic acids:** gluconic, malic, citric.
- **Enzymes:** invertase, glucose oxidase, amylase, catalase.
- **Amino acids:** proline as a marker of authenticity.
- **Minerals:** potassium, calcium, magnesium, copper, zinc, manganese.
- **Vitamins:** C, B-complex, pantothenic acid, niacin.
- **Phenolic compounds:** flavonoids (quercetin, kaempferol, pinocembrin), phenolic acids (ferulic, caffeic).

Botanical origin significantly influences composition and biological activity. For example:

- **Acacia honey** – light-colored, mild taste, high in fructose, suitable for people sensitive to glucose.
- **Chestnut honey** – dark, bitter, rich in flavonoids and minerals, strong antimicrobial effect.
- **Linden honey** – soothing effect on the nervous system, used for respiratory issues.
- **Manuka honey** – from New Zealand, high methylglyoxal (MGO) content, pronounced antibacterial effect.

These differences highlight the importance of knowing the source and quality of products.

Propolis – The Bees' Natural Antibiotic

Composed of resins, wax, essential oils, and polyphenols. Notable components such as caffeic acid phenethyl ester (CAPE), galangin, and pinocembrin are responsible for its antimicrobial and anti-inflammatory properties.

Royal Jelly – The Queen's Exclusive Food

Rich in Major Royal Jelly Proteins (MRJP), fatty acids (10-HDA), B vitamins, and hormones. These compounds are thought to contribute to the queen bee's longevity and fertility.

Pollen – A Nutrient Concentrate

Contains up to 30% protein, essential amino acids, enzymes, carotenoids, vitamins, and minerals, making it a dietary supplement for increased vitality.

Effects on Human Health

Honey and bee products act on multiple body systems simultaneously. Examples include:

- **Cardiovascular system:** Flavonoids improve endothelial function, reduce LDL oxidation, and increase HDL; studies show reduced blood pressure and improved lipid profiles with regular honey consumption.
- **Digestive system:** Honey has prebiotic effects due to oligosaccharides feeding beneficial gut bacteria (Bifidobacterium, Lactobacillus); used in gastritis and reflux due to its protective coating on mucosa.
- **Respiratory system:** Propolis reduces upper respiratory infections, especially in children; honey relieves cough and throat irritation, confirmed by randomized studies.
- **Nervous system:** Linden honey and royal jelly exhibit mild anxiolytic effects thanks to flavonoids and acetylcholine; bee products can improve cognition, concentration, and mood.
- **Skin and wounds:** Honey accelerates epithelialization, draws out exudate via osmotic effects, and reduces microbial load; propolis combats fungal infections of skin and mucosa.

Pharmacological Properties and Drug Interactions

Honey can increase the bioavailability of some medications or reduce gastrointestinal side effects. Propolis and royal jelly may interfere with immunomodulatory drugs; consultation with a physician is advised for long-term use.

Practical Application and Dosage (Approximate)

- Honey: 1–2 tablespoons (20–40 g) daily for adults.
- Propolis: 20–30 drops of tincture (10–20%) daily.
- Royal jelly: 100–500 mg daily.
- Pollen: 1–2 tablespoons of granules daily.

Forms of use include pure honey, blends with herbal extracts, capsules, and sprays.

Clinical Evidence

- Molan (2011): Manuka honey reduced chronic wound size by 40% compared to standard dressings.
- Esanu et al. (2019): Children taking propolis had 55% fewer respiratory infections during flu season.
- Izuta et al. (2018): Royal jelly increased estrogen levels in postmenopausal women and reduced hot flashes.
- Khalil et al. (2020): Pollen improved antioxidant status in athletes under intense training.

The global honey and bee product market is growing at 6% annually. Besides the food sector, bee products are increasingly important in the pharmaceutical, cosmetic, and nutraceutical industries. Their availability and promotion can significantly contribute to public health through preventive and safe effects.

Safety, Standardization, and Challenges

Honey and bee products vary widely in composition and effects. Residue analysis is essential as honey can be contaminated with pesticides, heavy metals, bacteria, and other harmful substances. Challenges include adulteration with syrups and sugars, which reduces nutritional and functional value, and allergic reactions to protein components—particularly propolis and pollen. Bee products have great potential in the health industry, especially with innovations such as standardized formulations, propolis nanoemulsions, and controlled-release royal jelly capsules. Combining bee products with plant extracts (e.g., honey + turmeric, propolis + echinacea) can enhance synergistic effects. Numerous biotechnological studies aim to identify new peptides in royal jelly with immunomodulatory potential.

Conclusion

Honey and bee products are valuable natural resources with proven multiple health benefits. As functional foods and natural supplements, they offer significant potential for preventing and treating a wide spectrum of diseases. Their integration into daily diets, under expert supervision and scientific verification, can reduce the risk of chronic non-communicable diseases and improve overall health. Further clinical studies are needed to define optimal dosages, achieve standardization, and confirm mechanisms of action.

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MED I PROIZVODI OD MEDA U OČUVANJU ZDRAVLJA LJUDI

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Sažetak: *Med i pčelinji proizvodi, poput propolisa, matične mliječi, polena i voska, predstavljaju značajan prirodni resurs s višestrukim zdravstvenim koristima za ljude. Zbog bogatstva biološki aktivnih tvari – antioksidansa, flavonoida, enzima, aminokiselina, minerala i vitamina – med nije samo prirodni zaslađivač, već i funkcionalna hrana s potencijalom prevencije i potpore u liječenju različitih bolesti. Med pokazuje snažno* ***antimikrobno, protuupalno, antioksidativno i imunomodulacijsko djelovanje****, što ga čini korisnim u prevenciji i terapiji infekcija, rana, gastrointestinalnih smetnji te respiratornih bolesti. Propolis, bogat flavonoidima i fenolnim kiselinama, efikasno djeluje protiv bakterija, virusa i gljivica, dok matična mliječ ima potencijal u regulaciji metabolizma i hormonalne ravnoteže. Polen doprinosi jačanju imuniteta i koristi se u nutritivnoj rehabilitaciji. Naučna istraživanja potvrđuju da redovita konzumacija kvalitetnog meda može poboljšati* ***lipidni profil, glikemijsku ravnotežu i antioksidativni status*** *organizma, posebice u kontekstu kroničnih nezaraznih bolesti poput kardiovaskularnih oboljenja, dijabetesa i karcinoma. Međutim, efekti meda zavise od njegovog botaničkog porijekla, kvaliteta i načina prerade.Uprkos brojnim prednostima, važno je ukazati na potrebu za* ***standardizacijom kvalitete meda****, sprečavanjem falsifikovanja te edukacijom potrošača o pravilnom korištenju pčelinjih proizvoda. Daljnja klinička istraživanja nužna su kako bi se potvrdila terapijska efikasnost i definisale preporučene doze u ljudskoj populaciji. Med i pčelinji proizvodi predstavljaju važan dio prirodne prevencije i podrške zdravlju ljudi. Njihova integracija u svakodnevnu ishranu, uz stručnu kontrolu i naučnu verifikaciju, može doprinijeti unapređenju javnog zdravlja i smanjenju rizika od kroničnih bolesti.*

Ključne riječi: *Med, proizvodi od meda, prevencija i terapija, zdravlje ljudi.*