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The Bee Bread as Super Food: An up-to-date Review in terms of Chronic Diseases

Süper Gıda Olarak Arı Ekmeği: Kronik Hastalıklar Açısından Güncel Bir İnceleme

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ABSTRACT

The Bee bread, a compound of pollen, honey, and bee salivary secretions, has garnered interest for its potential health advantages. This review synthesizes current scientific knowledge regarding bee bread's status as a superfood, particularly in the context of chronic diseases. It scrutinizes the nutritional profile of bee bread, emphasizing its abundance in vitamins, minerals, proteins, and bioactive compounds. Furthermore, it explores the antioxidant and anti-inflammatory properties associated with bee bread and investigates their potential roles in the prevention and management of chronic diseases. Recent research findings concerning the influence of bee bread on specific chronic conditions, such as cardiovascular diseases, diabetes, and neurodegenerative disorders, are deliberated. Additionally, the review probes potential mechanisms underlying the observed health effects, including the modulation of oxidative stress, inflammation, and cellular signaling pathways. Considering the safety and potential side effects of bee bread consumption, a thorough evaluation of its suitability as a dietary supplement is conducted. Existing gaps in the literature and avenues for future research are identified to inform further exploration into the therapeutic potential of bee bread in the context of chronic diseases. In conclusion, this review amalgamates existing evidence to furnish a comprehensive perspective on bee bread as a superfood, accentuating its conceivable role in fostering health and mitigating chronic diseases. The findings underscore the imperative for sustained research to elucidate the mechanisms of action and to establish evidence-based recommendations for its integration into dietary strategies aimed at enhancing public health.

Keywords: Bee, Bee bread, Chronic Disease, Fermented food, Health

ÖZET

Polen, bal ve arı tükürük salgılarının karışımından oluşan bir kovan ürünü olan arı ekmeği, potansiyel sağlık yararları nedeniyle dikkat çekmektedir. Bu güncel derleme, özellikle kronik hastalıklarla bağlantılı olarak arı ekmeğinin bir süper gıda olduğuna ilişkin mevcut bilimsel anlayışa odaklanmaktadır. Arı ekmeğinin besinsel bileşimini inceleyerek zengin vitamin, mineral, protein ve biyoaktif bileşik içeriğini vurgulamaktadır. Ayrıca arı ekmeğine atfedilen antioksidan ve antiinflamatuar özellikleri ve bunların kronik hastalıkların önlenmesi ve tedavisindeki potansiyel etkilerini araştırmaktadır. Arı ekmeğinin kardiyovasküler hastalıklar, diyabet ve nörodejeneratif bozukluklar dahil olmak üzere belirli kronik durumlar üzerindeki etkisine ilişkin son araştırma bulguları tartışılmakta ve oksidatif stres, inflamasyon ve hücresel sinyal yollarının modülasyonu gibi gözlemlenen sağlık etkilerinin altında yatan potansiyel mekanizmaları da ele almaktadır. Arı ekmeği tüketiminin güvenliği ve potansiyel yan etkileri de dikkate alınarak, bunun bir besin takviyesi olarak uygunluğunun kapsamlı bir değerlendirmesi yapılmaktadır. Literatürdeki mevcut boşluklar ve gelecekteki araştırma alanları, kronik hastalıklar bağlamında arı ekmeğinin tedavi edici potansiyeline yönelik daha ileri araştırmalara rehberlik etmek üzere belirlenmektedir. Sonuç olarak, bu güncel derleme, bir süper gıda olarak arı ekmeğine kapsamlı bir genel bakış sunmak için mevcut kanıtları sentezlemekte ve sağlığın geliştirilmesi ve kronik hastalıkların önlenmesindeki potansiyel rolünü vurgulamaktadır. Bulgular, etki mekanizmalarını tam olarak aydınlatmak ve halk sağlığını iyileştirmeyi amaçlayan diyet stratejilerine dahil edilmesi için kanıta dayalı öneriler oluşturmak için sürekli araştırmaya duyulan ihtiyacın altını çizmektedir.

Anahtar kelimeler: Arı, Arı ekmeği, Kronik hastalıklar, Fermente besin, Sağlık

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Introduction

Understanding Bee Bread: An Overview

The burgeoning interest in natural substances has become a focal point in the realm of dietetics, owing to their manifold benefits not only in terms of nutritional value but also for health purposes (1). The term *"Apitherapy" (bee therapy)* derives from the Latin word *"Apis mellifera L.,"* signifying *"honey bee,"* denoting an ancient medical practice and a domain where bee products find application (2).

Bee products, deemed 'functional foods,' augment nutritional value when added to other foods or consumed independently, owing to their inherent nutritional richness and high bioactive constituents (3). Their utilization has proliferated due to their nutritive and therapeutic attributes (4). Among these bee products is bee bread (Perga), a distinctive nutritional element synthesized by honey bees, distinguished by its rich bioactive content (5). Its potential impacts are under scrutiny, particularly in supporting general physiological processes. As exploration continues into the potential health benefits of bee bread, its role as a natural remedy, its influence on maintaining a healthy lifestyle, and its potential integration into nutritional regimens assume paramount importance (6,7).

Bee bread, also referred to as pollen bread, ensues from the natural amalgamation and fermentation of bee pollen, bee saliva, and flower nectar within hive cells. With its opulent nutritional content, it exhibits healing or prophylactic effects across various diseases, attributed to the bioactive molecules within its composition, thus meriting its classification as a functional product (8). Renowned for its nutrient richness, bee bread abounds in proteins, vitamins, minerals, antioxidants, and anti-inflammatory agents (1,4). Additionally, it demonstrates antimicrobial, antioxidant, antidiabetic, and anti-inflammatory properties (5).

The proteins, lipids, minerals, vitamins, flavonoids, and essential amino acids inherent in bee bread render it a pivotal nutritional source for both bees and humans (9). Facilitated by the fermentation of pollen by honey bees, it emerges as a more valuable food source for human consumption. This review endeavors to illuminate the significance of bioactive molecule richness in bee bread concerning its nutritional and chemical characterization, while summarizing in vitro studies elucidating its protective or therapeutic effects on human health.

The Composition of Bee Bread

Bee bread embodies distinctive characteristics pertinent to both humans and bees, primarily synthesized through the fermentation of pollen within comb cells induced by lactic acid bacteria (LAB) and yeast strains endemic to the environment (10). Termed "ambrosia," bee bread represents a concoction fashioned by honey bees within their hives (11). The viability of bee bread as a dietary supplement and nutraceutical hinges significantly on its chemical richness, which fluctuates contingent upon regional floral diversity and the season of pollen collection by bees (7,12). The chemical composition of bee bread varies according to plant sources, seasonality, geography, and soil composition (13). Across diverse locales worldwide, over 300 compounds, comprising free amino acids, sugars, fatty acids, minerals, organic acids, polyphenols, and vitamins, have been discerned in bee bread (6,14,15).

A scrutiny of Colombian bee bread unveiled substantial quantities of protein, vitamins, and phenolic compounds (15). A study assessing Anatolian samples to underscore bee bread's bioavailability and nutritional quality delineated carbohydrate, fat, and protein contents at 43%, 9.8%, and 19%, respectively (16). In another study, bee bread exhibited protein, fat, and sugar

contents ranging from 10-30%, 3-8%, and 25-50%, respectively (17). A Turkish study reported total phenolic, flavonoid, and antioxidant capacity values for bee bread extract as 6.93 mg GAE/g, 2.27 mg QE/g, and 83.62 μmol $FeSO_4.7H_2O$/g, respectively (18). Comparative assessment of bee pollen and bee bread digestibilities concerning protein contents revealed average digestibility scores of 69% and 76%, respectively, affirming bee bread's superior digestibility profile (19).

A salient feature of bee bread lies in its profusion of beneficial microorganisms, particularly Lactic Acid Bacteria (LAB) and yeasts. These probiotics play a pivotal role in intestinal health, fostering digestion, and maintaining intestinal microbial equilibrium (11). Defined by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), probiotics denote "live microorganisms that, when administered in adequate amounts, confer health benefits to the host" (20). Endowed with a rich probiotic milieu, bee bread encompasses a diverse array of microorganisms, comprising bacteria and fungi implicated in lactic fermentation during bee bread production. Toutiaee and colleagues reported the isolation of a Bacillus species evincing probiotic properties (21). The microbial composition of probiotic-endowed bee bread engenders diverse therapeutic effects (13).

Chronic Diseases and Bee Bread

Investigations have primarily focused on the antioxidant (22,23) and antimicrobial (24,25) activities of bee bread. Recent research has extended to its anti-obesity, anti-cancer, and anti-inflammatory properties (8,26).

A study exploring bee bread's impact on lipid metabolism administered three different doses (80 mg/kg, 400 mg/kg, and 800 mg/kg) to rats. Results indicated significant reductions in Fatty Acid Synthase (FAS) and Acetyl-CoA Carboxylase (ACC) concentrations in the liver, along with diminished expression levels of associated genes in bee bread treatment groups. Natural bee bread demonstrated positive regulatory effects on rat lipid metabolism, offering promise for hyperlipidemia treatment (27). Another study illustrated bee bread's potential in mitigating atherosclerosis progression in obese rats following a 0.5g/kg treatment regimen over 6 weeks (28).

In a rat model investigating chronic inflammation, bee bread administration augmented anti-inflammatory cytokines (IL-4, IL-10, and IL-1RA) while attenuating proinflammatory cytokines (IL-6, TNF-α, and IL-1β) (29). In a diabetic rat study, bee bread demonstrated favorable effects on glycemia, indicating potential for hyperglycemia treatment and management of diabetes-associated disorders (30).

Research exploring bee bread's nutritional value in postoperative wound healing revealed significant enhancements in tensile strength, fibroblasts, and neovascularization among malnourished rabbits supplemented with bee bread (31). Bee bread administration mitigated lipid peroxidation induced by obesity and positively influenced body weight regulation in a rat study (32).

In obese male rats, bee bread exhibited therapeutic effects against oxidative stress and inflammation in testicular tissues, presenting a potential avenue for obesity management (33). Eleazu et al. observed bee bread's preventive or ameliorative effects on obesity-induced muscle pathology and suggested its potential in energy intake suppression for obesity management (34).

In obese diabetic rats, bee bread treatment demonstrated promise in ameliorating lipid disorders and bone morphology (35). A study investigating bee bread's effects on serum lipid profiles in alloxan-induced diabetic rats evinced positive improvements in blood lipids (36).

Cytotoxicity studies revealed bee bread's moderate activity against cancer cells (EBB, A549, DU 145, and SH-SY5Y) (37). Another study investigating bee bread's effects on MDA-MB-231 breast cancer cells and its combined application with Doxorubicin and Cisplatin evinced reduced cytotoxicity and inhibited cancer cell migration (26).

Over 12 weeks, bee bread administration exhibited hepatoprotective effects against fatty liver disease associated with metabolic dysfunction in rats (38).

Furthermore, studies examining bee bread's ergogenic effects observed enhanced athletic performance during recovery phases in athletes receiving bee bread supplementation compared to controls, highlighting its potential in sports nutrition (39,40).

Bee bread is devoid of known side effects or risks, underscoring its medicinal properties and significance in the food market, thus warranting continued investigation.

The Future of Bee Bread: Natural Health Supplements

Bees amalgamate pollen with honey and digestive enzymes, which undergo fermentation by lactic acid, yielding "bee bread," a highly esteemed product. Beekeeping endeavors can introduce this valuable product to the market as a nutraceutical human food/dietary supplement. Bee bread boasts significant protein, vitamin, and phenolic compound content, serving as natural antioxidants. Regional flora profoundly influences bee bread components where colonies are situated. Honey bees ferment latent pollens within hives using various enzymes, amalgamating them with honey to create bee bread, which offers superior storage advantages compared to dried and frozen pollen, minimizing nutrient loss (3, 41).

Bee bread's rich composition holds historical therapeutic significance, with contemporary data corroborating its potential as a future medicine in dietary supplementation owing to its diverse bio-properties (4). Consumed as a dietary supplement, the fermented pollen mixture provides promising functional culture sources for the food industry, serving as a food preservative or facilitating the industrial-scale production of fermented foods with enhanced techno-functional properties (8).

Conclusions

Each year, novel research accompanies studies elucidating bee products' holistic impact on general health, with the significance of these studies steadily increasing. The pursuit of nourishing the body for a healthy lifestyle is actively pursued by numerous individuals today. Thus, consumption of health-preserving products emerges as a primary preference. In light of this burgeoning trend, the food industry is now offering products aligned with and supportive of this preference. Bee products, including honey, pollen, bee bread, royal jelly, and propolis, have ascended as functional foods with nutritive properties contributing to health maintenance (3,8,9). Bee bread's diverse nutritional profiles and potential health effects render it an intriguing subject for ongoing research.

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