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Ethno-pharmacological survey on the traditional use of bee pollen in Tunisia

Asma Sakraoui[1], Fatma Arrari[1], Anis Sakhraoui[2,3,4] and Monther Mejri[1]

[1]Laboratory of Functional Physiology and Valorization of Bio-Resources, Higher Institute of Biotechnology of Beja, University of Jendouba, Beja 9000,
[2]University of Jendouba, Higher School of Agriculture of Kef, Le Kef, Tunisia
[3]Carthage University, Higher School of Agriculture of Mograne, Department of Agricultural Production – Laboratory of Agricultural Production Systems and Sustainable Development (SPADD), LR03AGR02, Higher School of Agriculture of Mograne, Mograne, Zaghouan, Tunisia
[4]Universidad de Sevilla, Sevilla Departamento deBiología Vegetal y Ecología, Spain

ABSTRACT

Ethnopharmacology, at the crossroads of human and natural sciences, is devoted to exploring traditional medicines as sources of potential future treatments. In this context, our study aimed to conduct an ethnopharmacological survey investigating the traditional use of bee pollen in several regions of Tunisia. The survey comprised three main sections: demographic information about respondents (e.g., age, gender, and education level), identification and application of hive products, and details regarding the discovery and utilization of bee pollen, including diseases treated, preparation methods, and modes of administration. Our findings revealed that bee pollen is primarily used as a remedy for various ailments, with a notable focus on digestive disorders (32.7%). In terms of preparation, respondents commonly employed bee pollen in culinary applications (cooking: 31.2%, Viennese pastries: 19.9%, mixed with oat flakes: 22.2%), followed by infusion, capsules or tablets, and decoction methods (34.3%, 34.3%, and 15.9%, respectively). Oral administration was overwhelmingly preferred (76.9%). In conclusion, the insights gathered from residents of different regions regarding this medicinal bee product present compelling prospects for future therapeutic innovations. This data serves as a valuable foundation for further pharmacological and experimental studies aimed at exploring the medicinal potential of bee pollen.

KEY WORDS

Bee pollen; Ethno-pharmacology; Hives products; Phototherapeutic effect; Survey; Tunisia

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Introduction

Bee pollen is collected by beekeepers using specialized pollen traps placed at the entrance of beehives. Historically, the use of bee pollen as both a food source and therapeutic agent can be traced back to ancient civilizations, including Rome, Greece, Egypt, and China [1]. According to available data, global production of bee pollen is estimated to be around 1,500 tons per year [2]. However, market analysts suggest higher figures. For instance, the global bee pollen market was valued at approximately USD 833.9 million in 2023 and is projected to reach USD 1.25 billion by 2030 [3], growing at a compound annual growth rate (CAGR) of 6.1% from 2024 to 2030. Another report estimated the market size at USD 754.56 million in 2023, with expected growth to USD 1.1 billion by 2030 at a CAGR of 5.4 9% [4].The composition and properties of bee pollen vary significantly depending on its physical form (fresh, dried, or powdered) and its botanical origin (monofloral or polyfloral). These variations influence the concentration of bioactive compounds, which underlie bee pollen's wide range of applications in nutrition, medicine, and cosmetics [5]. Detailed data on bee pollen production and market size in Tunisia remains limited. However, the Middle East and Africa (MEA) region, which includes Tunisia, generated approximately USD 28.8 million in bee pollen revenue in 2024, with projections indicating a compound annual growth rate (CAGR) of 6.8% from 2025 to 2030 [6]. Tunisia is home to the resilient Tunisian honeybee (Apis mellifera intermissa), a species renowned for its ability to recover hives following dry seasons.

This resilience has played a significant role in shaping the country's beekeeping practices [7]. Recognized as a food additive, bee pollen is valued for its rich biological composition. On average, it contains significant amounts of reducing sugars, proteins, lipids, vitamins, and phenolic compounds [8]. Bee pollen is highly regarded as a beneficial dietary supplement, known to improve levels of haemoglobin, serum iron, total protein, and albumin. It can also contribute to weight gain [9]. The digestibility of bee pollen is impacted by factors such as the structure of the pollen wall and the number and thickness of germination pores [10]. In cosmetic applications, bee pollen is recognized for its ability to protect against skin aging, dryness, and hyperpigmentation. It effectively mitigates damage caused by ultraviolet radiation, oxidative stress, inflammation, and melanogenesis. Additionally, bee pollen exhibits antioxidant properties, anti-inflammatory effects [11], anti-wrinkle benefits, and provides moisturizing and cleansing effects. It also possesses antibacterial and antifungal activities [12] and helps maintain the skin's natural permeability barriers against water and electrolyte penetration while inhibiting melanogenesis [13]. These multifaceted properties highlight bee pollen's potential in various therapeutic and cosmetic formulations.Bee pollen is renowned for its diverse therapeutic properties, including local analgesic effects, lipid-lowering capabilities [14,15], potential anticancer properties [10,16], antiviral and anti-inflammatory actions [17], as well as hepatoprotective effects [17]. Moreover, bee pollen is noted for its antiatherosclerotic properties [18], antiallergic potential [19], immunostimulatory effects [11], and

***Correspondence:** Dr. Asma Sakaraoui, Department of Pharmaceutical Sciences, Maharshi Dayanand University, Haryana, India,
e-mail: asma.sakraoui@gmail.com

antitoxic capabilities [20]. These comprehensive therapeutic qualities underscore its potential in various health-promoting applications.

There is a significant global trade in bee pollen, with countries such as Canada, Australia, Mexico, Argentina, and Spain playing major roles [21]. However, there is incomplete information concerning human applications of bee pollen. This investigation aims to explore the nutritional and therapeutic uses of bee pollen in different regions of Tunisia.

Materials and Methods

Choice of region

We selected various regions of Tunisia, such as the Northwest, Northeast, West-Central, East-Central, Southwest, and Southeast, due to their abundance of medicinal and aromatic plants and the diversity of their bioclimatic conditions (Figure 1). According to [22], Tunisia features five bioclimatic stages, characterized by varying levels of aridity and humidity based on precipitation: i) The desert stage (Saharan), with rainfall below 100 mm annually. The arid stage, with precipitation ranging between 100 and 400 mm, often subdivided into upper and lower sub-stages, ii) the semi-arid stage, experiencing rainfall between 400 and 600 mm, typically divided into upper and lower sub-stages, iii) the sub-humid stage, where rainfall ranges from 600 to 800 mm and iv) the humid stage, marked by precipitation exceeding 800 mm per year.

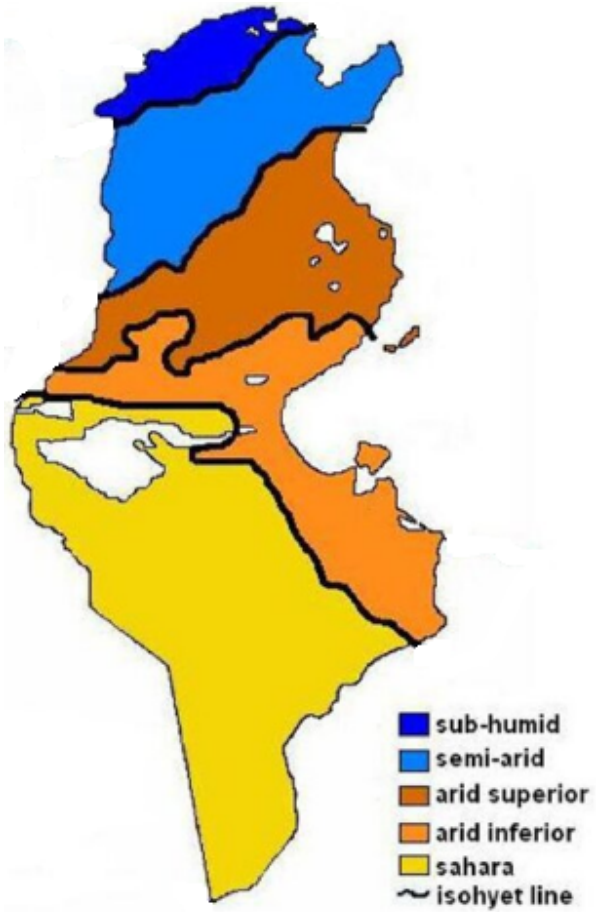

Figure 1. Bioclimatic stages of Tunisia.

Survey form presentation

The survey questionnaire consisted of three main sections. The first section focused on the identification of the interviewees, including their gender, age, education level, location, etc. The second section focused on the identification and usage of hive products such as honey, royal jelly, and bee pollen. The final section delved into inquiries regarding the utilization and acquisition of bee pollen, including the conditions treated, administration methods, and preparation techniques. All this information is crucial for gaining a comprehensive understanding of the medicinal properties and health benefits of bee pollen.

Methodology

A survey was conducted using an online questionnaire to maximize respondent participation from all regions, including scientists, botanists, traditional healers, and beekeeping experts. To facilitate this, the questionnaire was meticulously prepared and completed by each respective stakeholder.

Data analysis

The data was collected from the survey sheets and subsequently processed using Excel software. Quantitative variables were represented by numerical values, while qualitative variables were characterized by response frequencies. Data analysis employed simple descriptive statistical methods.

Results

The findings of this study are based on an extensive ethnopharmacological survey conducted across various regions of Tunisia. This approach facilitated the collection of comprehensive data on the consumption patterns and perceptions related to bee pollen. The methodology combined online questionnaires and interviews with local experts, ensuring a balanced representation of diverse user groups. The analyzed data highlight not only the preferences for bee pollen usage but also the motivations and perceived benefits associated with this product. Bee pollen, in particular, is widely used in traditional medicine to address influenza and digestive issues.

Demographic profile of study participants

The demographic profile of the participants was determined through online interviews. The distribution of respondents at the regional level was 16% for each region (Table 1). Among the participants, 45% were between 20 and 29 years of age, 45% were between the ages of 30 and 49, and 10% were over 50 years old (Figure 2A). The participant population was composed of 51.7% male and 48.3% female (Figure 2B). The results of the present study indicate that the majority of the professional population were university graduates (41.3%), followed by salaried employees (23.9%) and self-employed individuals (21.7%) (Figure 2C).

Table 1. Distribution of respondents in each region of Tunisia.

Regions	Percentage %
North west	16.5
North-east	16.66
West-Central	16.71
East-Central	16.1
Southwest	16.34
Southeast	16.71

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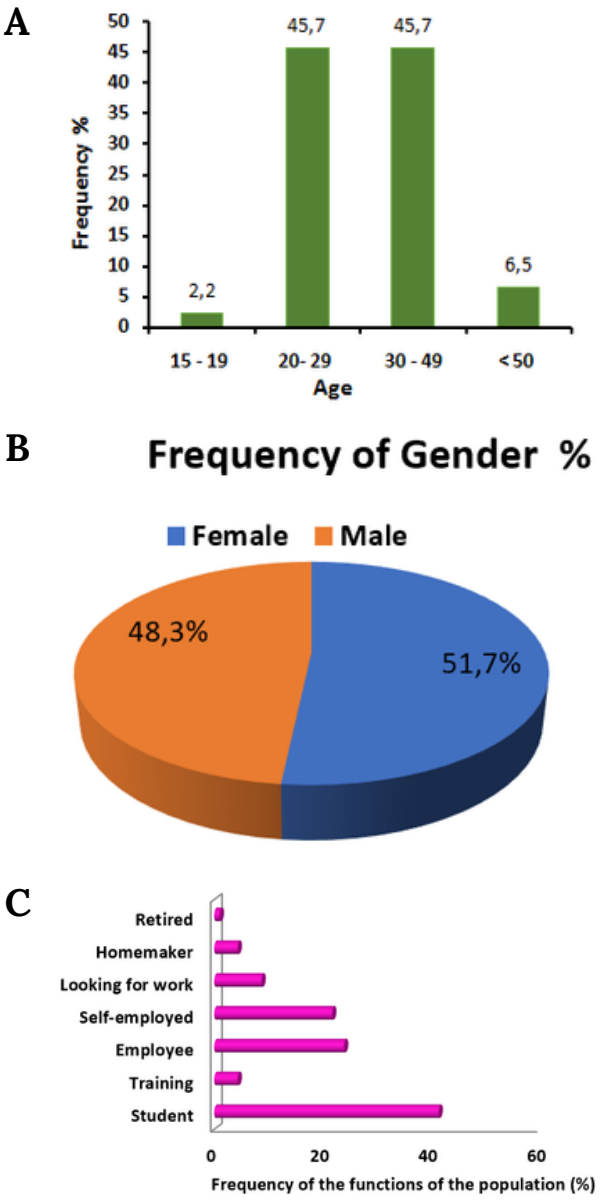

Figure 2. Demographic profile of respondents according to age group (A), Distribution of respondents by gender in Tunisia (B), and Inventories professional profile (C).

Identification and application of hive products

Consumer distribution of hive products

According to the Tunisian population, the majority of those surveyed belonged to the northeast region (60.9%), followed by the northwest region (32.6%). The central region was less represented compared to the north (15.2% and 6.5%, respectively), while a minority of individuals surveyed were located in the southwest and southeast (4.3% and 4.3%, respectively), as shown in Figure 3A.

Consumption trends of hive products

The survey findings reveal that honey is the most commonly used product among respondents (95.7%), followed by pollen (25.9%), royal jelly (20.9%), and other products such as bee swarms (2.2%) (Figure 3B).

Different varieties of honey consumed

Mountain honey is the most commonly used (54%), followed by eucalyptus honey (44%). Thyme honey is less frequently used (35%), as well as rosemary and all-flower honey (28%). Respondents also mentioned that orange honey is used with a frequency of 9% (Figure 3C).

Venues for buying hive products

Respondents indicated that beekeepers are the most frequently chosen source (69.6%), followed by large food distribution stores (26.1%), traditional shops (23.9%), and online orders (8.7%) (Figure 3D).

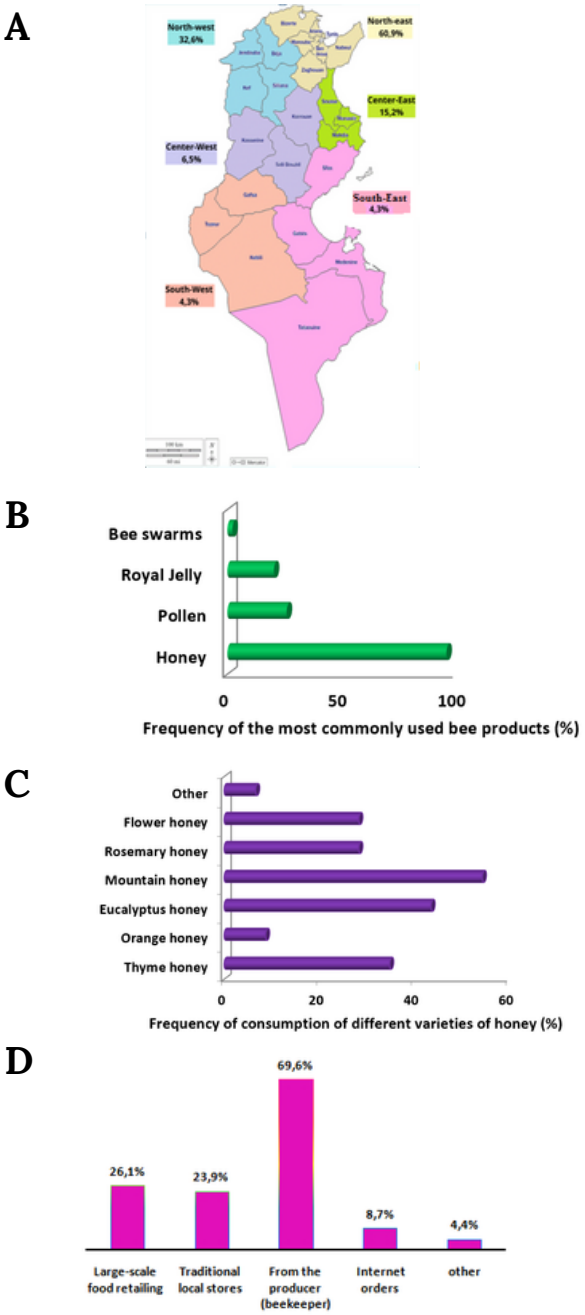

Figure 3. Consumer Demographics for Hive Products (A), Consumption of hive products (B), Types of Honey Consumed (C), and Points of Purchase for Hive Products (D).

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Selection criteria for hive products

When selecting hive products, consumers often consider several key criteria, such as quality, purity, health benefits, and origin. Perceived health benefits, such as nutritional value and potential medicinal properties, play a significant role in decision-making (69.3%). Additionally, consumers may prioritize products that are locally sourced or produced sustainably, reflecting growing concerns about environmental impact and supporting local economies (54.6%). Overall, price plays a crucial role in consumers' decisions (37.5%). Quality and purity are paramount, as consumers look for products that are free from contaminants and additives (texture 24.8%, fragrance variety 26.1%, colour 19.6%, and 5.9% for packaging) (Figure 4A).

Reasons for consuming hive products

The motives for using hive products vary but typically include the following:

Health benefits: Many people use hive products for their perceived health benefits, such as digestive disorders (65.9%), flu-like conditions (64.4%), hormonal stimulation (17.8%), and diabetes treatment (15.4%) (Figure 4B).

Sustainability: There is growing interest in sustainably sourced products with minimal environmental impact (45.4%).

Taste and Flavour: Hive products, especially honey, are consumed for their unique taste and flavour profiles (33.3%).

Comfort and Relaxation: Using hive products can provide comfort and relaxation (31.3%).

Administration method of hive products

Generally, the preparation is taken orally (97.8%) as a decoction in the form of tea or infusion for treating digestive and metabolic pathologies, as well as flu-like conditions. Topical application (22.2%) is employed for reducing toothache, inflammation-induced redness, and in cosmetics. The respiratory route (11.3%) via inhalation targets the upper and lower respiratory tracts, beneficial for conditions like respiratory infections (Figure 4C).

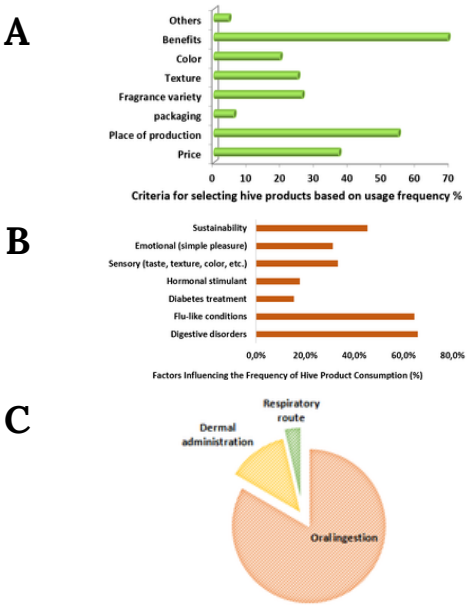

Figure 4. Criteria for choosing hive products (A), Motives for Using Hive Products (B), and Mode of Administering Hive Products (C).

Application and procurement of bee pollen

Percentage of bee pollen consumption

The latest findings showed that 80% of respondents consistently used phytotherapy with bee pollen instead of modern medicine to alleviate the side effects of synthetic drugs, 12% used it regularly, and 8% did not use it at all (Figure 5A).

Regional distribution of bee pollen in Tunisia

In Tunisia, most informants were from the northeast region (35.6%), followed by the northwest region (17.8%). The central east and southeast areas had less representation compared to the north (6.7% and 4.4%, respectively), while 0% of respondents were from the central west and southwest, as illustrated in Figure 5B.

Percentage of bee pollen purchases by location

Survey participants identified beekeepers as the most commonly selected source (37.8%), followed by large-scale food retailing (6.7%), traditional stores (4.4%), online orders, and pharmacies (2.2% each) (Figure 5C).

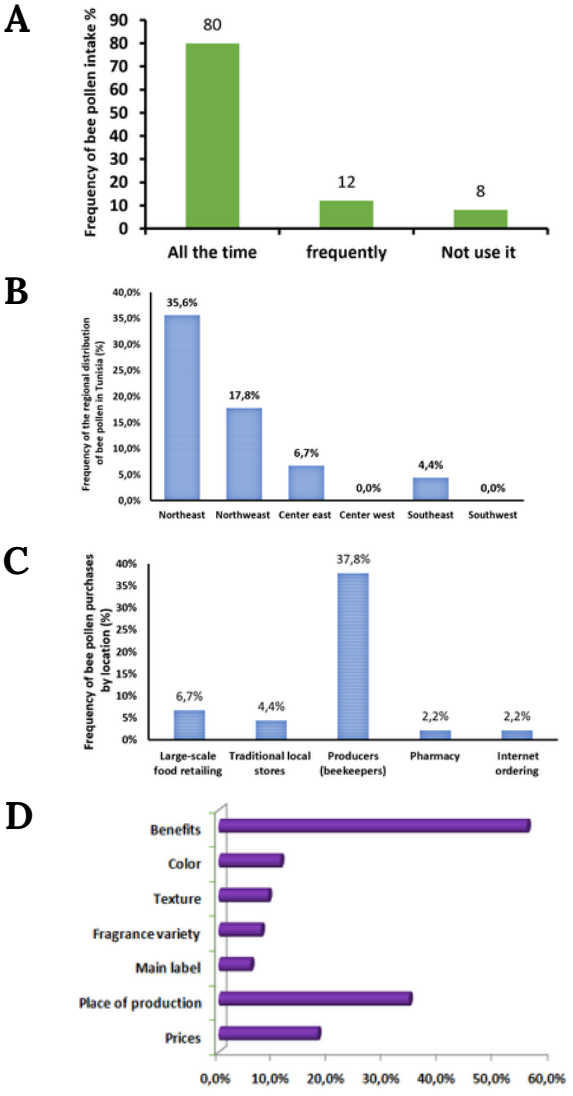

Figure 5. Bee pollen collection (A), Geographical spread of Bee Pollen (B), Breakdown of Bee Pollen place of Purchases (C), and Key Criteria for Selecting Bee Pollen (D).

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Bee pollen selection criteria

The findings indicate that various factors influence the choice of bee pollen. For instance, 55.6% of respondents reported using it for health benefits, including therapeutic purposes, cosmetic uses, and nutritional supplementation. Regarding source and purity, 34.3% preferred pollen sourced from reputable beekeepers (Figure 5D). The geographical origin of the pollen was also considered, with certain regions being known for producing high-quality pollen (22.3%). When it comes to colour, taste, and texture, fresh bee pollen typically ranges from golden yellow to orange or brown hues. It should have a slightly moist texture, pleasant aroma, and mild sweetness. Bitter or unpleasant flavours may indicate poor quality or contamination (11.1%, 8.9%, and 7.6%, respectively).

Therapeutic use

According to user perspectives, bee pollen is believed to offer therapeutic benefits for a range of conditions, including digestive disorders (32.7%), anti-inflammatory diseases (25.3%), flu-like conditions (20%), diabetes treatment (15.2%), anaemia (13.3%), weight management (6.7%), and hormonal stimulation (6.7%) (Figure 6A).

Administration mode

Bee pollen is typically consumed orally in approximately 76.9% of cases, either directly or mixed with food or beverages, allowing for easy assimilation of nutrients into the body. Topical application accounts for 33.7%, often for skincare or wound healing. Inhalation via the respiratory route represents 14.4% of usage but should be approached cautiously due to potential allergic reactions (Figure 6B).

Utilization patterns

As shown in Figure 6C, the majority of respondents (76.9%) used fresh bee pollen, indicating a preference for its natural form. A smaller percentage (33.9%) opted for dried bee pollen, suggesting occasional use or storage preference. This variety highlights the versatility of bee pollen in culinary and nutritional applications.

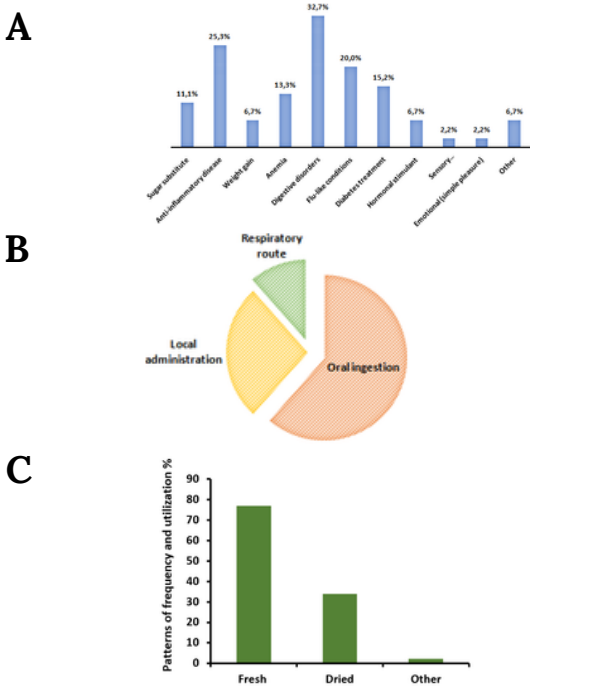

Figure 6. Ethnopharmacological survey on traditional and medicinal use of bee pollen (A), Administration methods of bee pollen (B), and Utilization state (C).

Nutritional usage

Survey participants indicated a preference for mixing bee pollen with various substances: tea, coffee, and infusions (42.4%), incorporating it into food through cooking (31.2%), such as oat flakes (22.2%), Viennese pastries (19.9%), juice, salad, energy bars, yogurt, and chocolate to mask its taste or enhance nutritional intake. Bee pollen is also available in capsules or tablets (34.3%), providing a convenient way to consume standardized doses. Some respondents suggested preparing it as a decoction from spray-dried powder (15.9%) (Figure 7A).

Source of information

Only 33.3% of participants obtained information from the internet and specialty social media, followed by 13.3% from scientific references, 11.1% from nutritionists or doctors, and 5.3% from training. Meanwhile, 56.7% used bee pollen based on others' experiences (Figure 7B).

Frequency of satisfaction levels

The majority of informants expressed satisfaction with bee products, with 69% indicating they were satisfied, while 25% reported being very satisfied (Figure 7C).

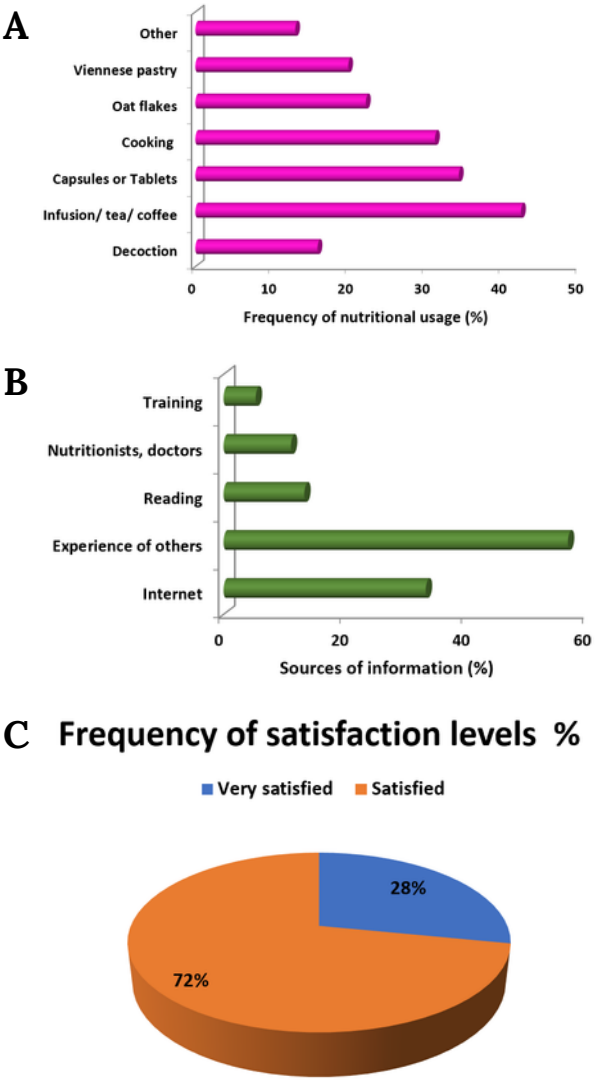

Figure 7. Preparation mode (A), Acquired information (B), and Ethnopharmacological survey on satisfaction rate of bee pollen (C).

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Discussions

Through our ethno-pharmacological survey conducted in Tunisia, we have gathered extensive information on the traditional use of hive products, especially bee pollen. This research has significantly enhanced our understanding of its applications in local populations. The method used involved collecting data through questionnaire forms, revealing that women (51.7%) among the informants were the most knowledgeable and experienced with this bee product. Most of them use it in the kitchen to flavour and season various foods such as salads, yogurt, juices, and Viennese pastries. This finding is consistent with those of Vit et al. [23], who showed that in Brazil, nutritional pollen is utilized in various ways, including as an ingredient in salad dressings and sugar syrups, and is often added to juices or mixed with vitamins, yogurt, or honey [23]. The median age of the participants ranged from 20 to 90, with the majority between 30 and 49 years old, and they had high education levels. Similar findings were reported in studies conducted in Algeria [20].

The ethnopharmacological findings highlight the predominant use of bee pollen in traditional medicine for addressing gastrointestinal issues. Bee pollen may influence the composition of gut microbiota, promoting a healthy balance of beneficial bacteria and potentially improving gut health (23,24 %). Some studies indicate that bee pollen can aid digestion by supporting the production of digestive enzymes and enhancing nutrient absorption [25]. It has also been suggested that bee pollen might help strengthen the intestinal mucosal barrier, which plays a crucial role in protecting against pathogens and maintaining gut integrity [26]. Furthermore, several studies have underscored hormonal improvements (14,28 %), which contribute to hypolipidemic and hypoglycaemic effects due to unsaturated fatty acids [29]. Moreover, polyphenols in bee pollen have been recognized for their detoxifying and anti-inflammatory properties [30]. Our study also highlighted the therapeutic effects of bee pollen, particularly its potential protective effects against flu-like conditions, although research in this specific area is limited. Some potential mechanisms and benefits include immune modulation by bee pollen, which contains various nutrients, including vitamins, minerals, and antioxidants that may support immune function [31]. By boosting the immune system, bee pollen could potentially help the body defend against viral infections that cause flu-like symptoms [32].

According to responses from our informants, bee pollen is primarily prepared in various ways: through food (cooking: 31.2%, Viennese pastry: 19.9%, mixed with oat flakes: 22.2%), infusion (34.3%), capsules or tablets (34.3%), and decoction (15.9%). The recommended apitherapeutic dosage for bee pollen is 20–40 grams per day [33]. In recent years, bee pollen products have been developed in various forms such as granules, tablets, candy bars, oral liquids, and tonics for human consumption [34,35]. It is noteworthy that respondents commonly use either fresh (76.9%) or dried forms (33.9%) in these preparations. Oral administration is the predominant method (76.2%) [36], followed by local administration (33.7%). The application of bee pollen in cosmeceuticals aims to prevent the penetration of cosmetic ingredients like surfactants, water, and electrolytes that accelerate skin aging [13]. This protective function underscores its potential in skincare formulations to maintain skin health and appearance.

Bee pollen is a mixture of floral pollens collected by bees, known for its diverse composition containing numerous compounds [37]. It includes proteins, carbohydrates, free amino acids, lipids, vitamins, carotenoids, folic acid, and minerals, with varying levels depending on the source flowers [38]. Additionally, flavonoids, phenolic acids, and their derivatives are significant constituents, valued for their bioactive properties [39].

Finally, following this survey, bee pollen stands poised to establish itself as a natural and biological alternative to synthetic drugs, thus playing a crucial role in the innovation and therapeutic revolution within phytotherapy. The ethnopharmacological approach provides a robust framework for advancing to the laboratory stage, where scientific research can further substantiate the biological properties and medicinal qualities of bee pollen. This progression aims to validate its potential benefits for enhancing both human and animal health, thereby promoting its broader adoption in medical and veterinary practices.

Conclusions

Based on the results of this study and ethnopharmacological analysis, we found that bee pollen is extensively incorporated into both culinary practices and traditional medicine among Tunisian communities. These populations affirm its beneficial effects on various physiological systems, particularly in the management of digestive disorders, diabetes, anti-inflammatory conditions, and anemia, thereby positioning it as a functional food. The insights gathered provide a valuable dataset for future research in pharmacology, phytochemistry, and biochemistry, which could lead to the discovery of novel bioactive molecules and the development of new pharmaceuticals derived from bee pollen. Furthermore, such research will enable the evaluation of the efficacy and safety of these compounds, and facilitate the exploration of their biological activities through in silico, in vivo, and in vitro methods.

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Research Ethics Committee Approval

The research paper was permitted to be published in any open access journal.

Conflict of Interest

The authors of the paper have no conflict of interest.

References

1. Wade C. Carlson Wade's New fact book on bee pollen and your health. Pivot original health book. 1978.
2. Eshete Y. Bee pollen production, physicochemical and bio-functional properties, and safety utilization: A review. Nutr Res Food Sci J. 2021;4(1):1-0. https://doi.org/10.31038/NRFSJ.2021415
3. Size GH. Share & Trends Report, 2030. Market Research Reports & Consulting. Grand View Research. https://www.grandviewresearch.com/industryanalysis/lactic-acidand-poly-lactic-acid-market.2024
4. Maximize Market Research. Bee Pollen Market: Size, Dynamics, Regional Insights and Market Segment Analysis 2030. 2023.

https://doi.org/10.61577/jnh.2025.100008

5. Singh S. Bee Pollen Market Research Report Forecast to 2032. Market Research Future; 2023.
6. Slow Food Foundation for Biodiversity. Tunisian Honeybee.
7. Campos MG, Frigerio C, Lopes J, Bogdanov S. What is the future of Bee-Pollen. J ApiProd. ApiMed. Sci. 2010;2(4):131–144.
8. Campos MG, Bogdanov S, de Almeida-Muradian LB, Szczesna T, Mancebo Y, Frigerio C, et al. Pollen composition and standardisation of analytical methods. J Apic Res. 2008;47(2):154–161. https://doi.org/10.1080/00218839.2008.11101443
9. Xie Y, Wan B, Li W. Effect of bee pollen on maternal nutrition and fetal growth. J West China Univ Med Sci. 1994;25(4):434–437.
10. Roulston TH, Cane JH. Pollen nutritional content and digestibility for animals. Plant Syst Evol. 2000;222(1):187–209. https://doi.org/10.1007/BF00984102
11. Denisow B, Denisow-Pietrzyk M. Biological and therapeutic properties of bee pollen: A review. J Sci Food Agric. 2016;96(13):4303–4309. https://doi.org/10.1002/jsfa.7729
12. AbdElsalam E, Foda HS, Abdel-Aziz MS, Abd FK. Antioxidant and antimicrobial activities of Egyptian bee pollen. Middle East J Appl Sci. 2018;8(4):1248–1255.
13. Xi X, Li J, Guo S, Li Y, Xu F, Zheng M, et al. The potential of using bee pollen in cosmetics: A review. J Oleo Sci. 2018;67(9):1071–1082. https://doi.org/10.5650/jos.ess18048
14. Samochowiec L, Wójcicki J. Influence of Cernitin extracts on serum and liver lipids in rats fed on a high-fat diet. Herba Pol. 1983;29:165.
15. Kacemi R, Campos MG. Translational research on bee pollen as a source of nutrients: A scoping review from bench to real world. Nutrients. 2023;15(10):2413. https://doi.org/10.3390/nu15102413
16. Furusawa E, Chou SC, Hirazumi A, Melera A. Antitumour potential of pollen extract on Lewis lung carcinoma implanted intraperitoneally in syngeneic mice. Phytother Res. 1995;9(4):255–259. https://doi.org/10.1002/ptr.2650090405
17. Eraslan G, Kanbur M, Silici S, Liman BC, Altınordulu Ş, Sarıca ZS. Evaluation of protective effect of bee pollen against propoxur toxicity in rat. Ecotoxicol Environ Saf. 2009;72(3):931–937. https://doi.org/10.1016/j.ecoenv.2008.06.008
18. Rzepecka-Stojko A, Stojko J, Jasik K, Buszman E. Anti-atherogenic activity of polyphenol-rich extract from bee pollen. Nutrients. 2017;9(12):1369. https://doi.org/10.3390/nu9121369
19. Ishikawa Y, Tokura T, Ushio H, Niyonsaba F, Yamamoto Y, Tadokoro T, et al. Lipid-soluble components of honeybee-collected pollen exert antiallergic effect by inhibiting IgE-mediated mast cell activation in vivo. Phytother Res. 2009;23(11):1581–1586. https://doi.org/10.1002/ptr.2824
20. Bouazza S, Demmouche A, Mai H, Brikhou S, Bensaoud S, Djabour F. Expert survey on bee pollen uses in Sidi Bel Abbes (Algeria). Bee World 2020;97(1):6–9. https://doi.org/10.1080/0005772X.2019.1700656
21. Van Eaton C, Law R. Marketing apitherapy products and the challenge of government regulation. Bee World. 2000;81(3):109–115. https://doi.org/10.1080/0005772X.2000.11099480
22. Emberger L. Traité de Botanique Systématique, Les Végétaux Vasculaires. Tome II ; 1960.
23. Vit P, Pedro SRM, Roubik DW, eds. Pot-Pollen in Stingless Bee Melittology. Springer Cham; 2018.
24. Cheng N, Chen S, Liu X, Zhao H, Cao W. Impact of Schisandra chinensis bee pollen on nonalcoholic fatty liver disease and gut microbiota in high-fat diet induced obese mice. Nutrients. 2019;11(2):346. https://doi.org/10.3390/nu11020346
25. Ilie CI, Oprea E, Geana EI, Spoiala A, Buleandra M, Gradisteanu Pircalabioru G, et al. Bee pollen extracts: Chemical composition, antioxidant properties, and effect on the growth of selected probiotic and pathogenic bacteria. Antioxidants. 2022;11(5):959. https://doi.org/10.3390/antiox11050959
26. Ricigliano VA, Fitz W, Copeland DC, Mott BM, Maes P, Floyd AS, et al. The impact of pollen consumption on honey bee (Apis mellifera) digestive physiology and carbohydrate metabolism. Arch Insect Biochem Physiol. 2017;96(2):e21406. https://doi.org/10.1002/arch.21406
27. Zhang H, Liu M, Song F, Zhu X, Lu Q, Liu R. Fermentation enhances the amelioration effect of bee pollen on Caco-2 monolayer epithelial barrier dysfunction based on NF-κB-mediated MLCK-MLC signaling pathway. Food Res Int. 2024;178:113938. https://doi.org/10.1016/j.foodres.2024.113938
28. Manning R. Fatty acids in pollen : A review of their importance for honey bees. Bee World. 2001;82(2):60–75. https://doi.org/10.1080/0005772X.2001.11099504
29. El Ghouizi A, Bakour M, Laaroussi H, Ousaaid D, El Menyiy N, Hano C, et al. Bee pollen as functional food: Insights into its composition and therapeutic properties. Antioxidants. 2023;12(3):557. https://doi.org/10.3390/antiox12030557
30. Rzepecka-Stojko A, Stojko J, Kurek-Górecka A, Górecki M, Kabała-Dzik A, Kubina R, et al. Polyphenols from bee pollen: Structure, absorption, metabolism and biological activity. Molecules. 2015;20(12):21732–21749. https://doi.org/10.3390/molecules201219800
31. Al-Kahtani SN, Alaqil AA, Abbas AO. Modulation of antioxidant defense, immune response, and growth performance by inclusion of propolis and bee pollen into broiler diets. Animals. 2022;12(13):1658. https://doi.org/10.3390/ani12131658
32. Bakour M, Ferreira ICFR, El Ghouizi A, et al. New insights into potential beneficial effects of bioactive compounds of bee products in boosting immunity to fight COVID-19 pandemic: Focus on zinc and polyphenols. Nutrients. 2022;14(5):942. https://doi.org/10.3390/nu14050942
33. Komosinska-Vassev K, Olczyk P, Kaźmierczak J, Mencner L, Olczyk K. Bee pollen: Chemical composition and therapeutic application. Evid Based Complement Alternat Med. 2015;2015:297425. https://doi.org/10.1155/2015/297425
34. Bogdanov S. Pollen: Nutrition, functional properties, health. Magnesium. 2012;20:350.
35. Campos M, Markham KR, Mitchell KA, da Cunha AP. An approach to the characterization of bee pollens via their flavonoid/phenolic profiles. Phytochem Anal. 2015;8(4):181–185.https://doi.org/10.1002/(SICI)10991565(199707)8:4%3C181::AID-PCA359%3E3.0.CO;2-A
36. Mărgăoan R, Strant M, Varadi A, Topal E, Yücel B, Cornea-Cipcigan M. Bee collected pollen and bee bread: Bioactive constituents and health benefits. Antioxidants. 2019;8(12):568. https://doi.org/10.3390/antiox8120568

https://doi.org/10.61577/jnh.2025.100008

37. Mărgăoan R, Mărghitaş LA, Dezmirean DS, Dulf FV, Bunea A, Socaci SA, et al. Predominant and secondary pollen botanical origins influence the carotenoid and fatty acid profile in fresh honeybee-collected pollen. J Agric Food Chem. 2014;62(27):6306–6316. https://doi.org/10.1021/jf5020318

38. Graikou K, Kapeta S, Aligiannis N, Sotiroudis G, Chondrogianni N, Gonos E, et al. Chemical analysis of Greek pollen - Antioxidant, antimicrobial and proteasome activation properties. Chem Cent J. 2011;5(1):33. https://doi.org/10.1186/1752-153X-5-33

39. Kalaycıoğlu Z, Kaygusuz H, Döker S, Kolaylı S, Erim FB. Characterization of Turkish honeybee pollens by principal component analysis based on their individual organic acids, sugars, minerals, and antioxidant activities. LWT-Food Sci Technol. 2017;84:402–408. https://doi.org/10.1016/j.lwt.2017.06.003

https://doi.org/10.61577/jnh.2025.100008