Scientific Bulletin. Series F. Biotechnologies, Vol. XXVI, No. 2, 2022
ISSN 2285-1364, CD-ROM ISSN 2285-5521, ISSN Online 2285-1372, ISSN-L 2285-1364

THE ANTIOXIDANT EFFECT OF RAW BEE POLLEN COLLECTED FROM ECOLOGICAL CROPS - MINIREVIEW

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Abstract

Bee products containing bee pollen collected from flowers and harvested by humans from the hive, include both active principles produced by plants and active principles added during collection, processing, and storage by bees. Pollen, is one of the most bee products used in apitherapy, is a valuable source of bioactive substances, as it contains most of the active ingredients that are directly assimilable in the human body (vitamins, minerals, hormones and substances acting as prehormones, enzymes and simple carbohydrates) and have by adding in the diet a wide range of indications, recommendations and applications. As a result, this mini-review systematically presents both the highlighting of the influence of pollen in daily human consumption and the analysis of composition, antioxidant activity, quality parameters and sensory properties of biologically active pollen harvested from organically grown honey crops.

Key words: *antioxidant activity, bee pollen, honey, phenolic compounds.*

INTRODUCTION

Organic beekeeping provides food security and contributes to the quality of life in rural areas, especially in beekeeping practices (Martinello et al., 2021).
Bees are the dominant pollinators of most flowering plants globally and are important for the pollination of many crops. 71% of the plants which generate food worldwide are pollinated by bees (FAO, 2022).
Pollinators are especially important for the conservation of plant biodiversity (Martinello et al., 2021).
Martinello & Mutinelli (2021) pointed out that bees could be considered as active bio-samplers of environmental pollution and possible warning biomarkers for human health through the importance related to human welfare through pollination and production of honey and other bee products.
Most contaminants accumulate in wax (Walsh et al., 2021), but also in other bee products (Zawislak et al., 2019).
The need for ecologic beekeeping farms and organic farming is of vital importance for biodiversity conservation and human health, as this argument has not been fully researched in the scientific community, according to our knowledge.
Rahimi et al. (2020) in the scientific paper "*Organic Beekeeping Practices in Romania: Status and Perspectives towards a Sustainable Development"*, drew attention on the importance of using certain conceptual assessment models in the case of sustainability for the organic beekeeping sector.
This concept is also supported by Kouchner et al. (2018), highlighting the lack of necessary tools for sustainability assessment in this field, and suggesting an assessment system dedicated exclusively to the cultivation of organic plants in order to obtain bee products with perfect antioxidant potential.
Currently, beekeeping is an important sector that is developing a strong focus on organic crops. In general, organic beekeeping is practiced separately from the rest of mainstream agriculture. The clear principles applied to organic farming are also strictly applied in the practice of organic beekeeping and are regulated by legislation (MADR, 2022) and certified by European recognized certification bodies (e.g. Ecocert).
The clear principles of organic beekeeping are to support the health and vitality of bee colonies

with great care and attention, and to minimize negative influences on the environment and especially on consumers of bee products.
First and foremost, the beekeeper must have extensive expert knowledge of natural bee behavior and organic hive methods (Pocol et al., 2021).
For a sustainable development of ecological beekeeping, an important measure is training to increase the level of socio-cultural development of the parties involved in this process: farmer - beekeeper. Education for the growth and development of ecological services with modern technologies targeted at farmers and beekeepers. In addition to these support measures, there is a need for the development of support programmes for stakeholders in organic farming and beekeeping and the ability to understand the legislation, according to Juríčková et al. (2020). Their research (Juríčková et al., 2020) sees organic farming as a 'sustainable' farming system offers a potential solution for sustaining biodiversity by contributing to environmental protection.

THE NUTRITIONAL ANALYSIS OF POLLEN

Modern agricultural systems use both bees and wild pollinators to provide pollination, which have the ability to pollinate in confined spaces or cold temperatures. The decline of bee species due to the increased use of pesticides raises concerns about pollination in agriculture. The number of farmers is quite low in terms of adopting more environmentally friendly practices for pollination. This mini-review aims to identify an eco-economic model at the bee farm level to explore the impact of pollination on organic crop production.
This study evaluates farmers' decisions of adopting and optimizing organic crops with a well-defined role in ensuring pollination and the good development of bee and other pollinators.
Results show that through various organic farming and beekeeping sustainability schemes, effectively for encouraging and implementing new farming practices to ensure pollination and maintenance of organic beehives and viable pollinators, farmers are willing to cultivate organic honey crops for pollen collection maintenance (Kleftodimos et al., 2021).
According to a study conducted by researchers (Feás et al., 2012) it appears that the antioxidant activity of pollen is higher due to the fact that it comes from organic plant crops.
Analysis of the origin of pollen from different geographical areas is especially important to identify the antioxidant value of pollen and the organic plants of origin.
Through palynological analysis, it is possible to identify the floral areas, the vegetation in certain honey bases, very importantly the honey species that have been of interest to bees in certain periods.
The nutritional analysis of pollen collected by bees, made by researchers, has revealed that it is an excellent source of energy (Feás et al., 2012). For example, pine (*Pinus sylvestris* **L.**), corn (*Zea mays*) and common reed *Phragmites australis*) pollen contain: 13.92; 36.59; and 31.93% total carbohydrates, 13.45; 20.32; and 18.90% protein; 1.80; 3.7; and 1.16% lipids and 2.35; 4.90; and 3.80% total ash, respectively. It is obvious that, by analyzing these pollen sources, we can also identify the organic honey plants that honeybees (*Apis melifera* L.) visit predominantly (Feás & Estevinho, 2011).
The increased interest in recent times of researchers in an older ecological plant has been studied (Berti et al., 2016), in the paper *Camelina uses, genetics, genomics, production, and management*, which, according to the researchers, sown in autumn, but also in spring, provides pollen for honeybees as well as for wild pollinators, both in season and between the harvest of the main honey plants. Researchers say that, through this pollination mechanism, the camelina provides an abundance of nectar.
Camelina sown in late fall begins flowering in early May and camelina sown in early spring begins flowering in late June, both of which flower much earlier than soybean, rapeseed, sunflower in the same area (Eberle et al., 2015; Thom et al., 2016).
Camelina sown in late autumn yielded more pollen (100 kg/ha) than rapeseed (*Brassica napus oleifera*) (82 kg/ha) (Eberle et al., 2015).
Camelina flowers are a particularly reliable source of pollen and nectar, providing 100 to 250 kg of honey a year to a family of bees (Axel et al., 2011).
Moreover, organic plants, *Camelina species, C. microcarpa* and *C. alyssum* are visited by

honeybees more frequently (Séguin-Swartz et al., 2009), and according to the Canadian Food Inspection Agency (CFIA, 2012) provides abundant pollen compared to the shepherd's teat (*Capsella bursa pastoris*) a plant with important therapeutic properties.

Numerous specialized studies (Faure & Tepfe 2016) show the importance of antioxidants in camelina oil, high levels of omega-3 lipids, vitamin E, are beneficial to human health (Zubr 1997).

The classical method of collecting raw pollen collected by bees consists of fixing a pollen collector with holes of 5 mm in diameter in front of the hive warp, which has a collecting drawer. Bees need a high variability of pollen sources for the harmonious development of the colony (Abramovic & Abram, 2005).

Honeybees have the ability to produce about 6 different hive products used in apitherapy (Kolayli & Keskin, 2020) honey, pollen, propolis, royal jelly, shepherd's purse, bee venom, and a more recent hive product apilarnil discovered by Ilieșiu in 1980.

Table 1 shows the total content of polyphenolic compounds, flavonoids, phenolic acids, anthocyanins, and carotenoids in polyfloral honey with added pollen according to (Habryka et al., 2021). The higher the pollen addition in honey (Tomczyk et al., 2019), the higher the content of phenolic compounds in the honey analyzed by (Habryka et al., 2021), reaching a value of 178.26 mg GAE/100 g (Table 1) for the sample with the largest addition of grams of bee pollen.

Table 1. The total phenolic, flavonoid, phenolic acid, anthocyanin, and carotenoid content in multiflower honey and honeys enriched with bee pollen.

Addition of Bee Pollen (%)	Total Phenolic Content (mg GAE/100 g)	Total Flavonoid Content (mg QE/100 g)	Total Phenolic Acid Content (mg CAE/100 g)	Total Anthocyanin Content (mg/100 g)	Total Carotenoid Content (mg/100 g)
0	30.75 ± 0.25	2.77 ± 0.29	11.02 ± 0.68	2.01 ± 0.05	0.138 ± 0.001
5	63.33 ± 0.27	5.94 ± 0.25	16.65 ± 0.19	4.02 ± 0.05	0.311 ± 0.004
10	89.42 ± 0.61	8.38 ± 0.19	17.08 ± 0.23	5.57 ± 0.38	0.934 ± 0.001
15	136.63 ± 0.44	12.11 ± 0.48	20.32 ± 0.52	7.60 ± 0.19	1.404 ± 0.002
20	156.13 ± 0.92	14.25 ± 0.27	21.26 ± 0.39	9.16 ± 0.09	1.726 ± 0.001
25	178.26 ± 1.13	16.39 ± 0.16	24.44 ± 0.17	11.32 ± 0.10	2.333 ± 0.001
$LSD_{0.05}$	0.83	0.36	0.51	0.22	0.003

Table source: Habryka et al., 2021.

According to the study Kocot et al. (2018), the phenolic acid content of pollen can even reach 190 mg/100 g, with gallic acid being the most important representative of that.

The medicinal properties of these products were recognized thousands of years ago by ancient civilizations, although in modern times they have limited use.

Hive products are complete sources of bioactive compounds, macro- and micronutrients, which in a comprehensive way confer multiple biological actions to these by-products, such as, for example, antimicrobial, antioxidant, and anti-inflammatory properties (Giampieri et al., 2022).

Bee products, represent an inexhaustible source of natural antioxidants, including phenolic acids, flavonoids and terpenoids, as well as numerous other phytochemicals, which are able to ameliorate the effects of oxidative stress underlying cause of many diseases (Martinello et al., 2021).

Pollen consists of a multitude of microscopic corpuscles contained in pollen sacs in the anthers of plant flower stamens.

Physiologically, they are tiny granules that constitute the male fertilized elements of the flower (male reproductive part) (Ialomiteanu, 1976).

According to a study by Dr. Rawhi (2012), bees harvest more than 300,000 pollen grains in a single transport, as they have three pairs of limbs, anterior, median, and posterior.

The bee's limbs are morphologically adapted to perform specific pollen-collecting functions

(Beekeepers Association - Beekeeping Research and Development Institute, 2012).

The pollen grain has a diameter of 1:50 000 µm, and the bee collects about 12 - 15 mg of pollen in a single transport, equal to one tenth of its weight (Rawhi, 2012).

The weight of the pollen grain differs according to the atmospheric humidity, floral origin, but also to the orientation ability and vitality of the bee. After harvesting, the pollen is transported to the hive, stored in honeycombs, enhanced with enzymes, enriched with enzymes and a little honey and then the bee presses it into the honeycomb cell.

Collection by the beekeeper is carried out by various techniques before it is stored in the combs (Francis-Baker, 2021).

The pollen collected by the beekeeper holds the color of the flowers visited by the bees. The chemical structure of the pollen varies significantly depending on the weather conditions during harvesting and the development of the floral anthers.

Pollen is considered a rich product of bioactive ingredients, including proteins, carbohydrates, lipids, phenolic compounds, and vitamins (Spulber et al., 2020).

By drying, pollen loses vitamins, aminoacids, volatile substances, biological water, lactic flora with antibacterial activities, lactoferments.

Frozen raw pollen retains all these active elements, as well as the intense taste and pastel colors.

Freshly frozen, raw pollen can be kept at a temperature of -5 to -15°C.

The raw pollen in the collector must be cleaned of impurities and foreign bodies, left to dry in the shade, protected from sunlight, heat, moisture, dust, and insects.

Ultraviolet rays destroy pollen, the atmospheric temperature should not exceed 40-45°C and it is very important not to use air fans.

Fresh raw pollen can be left at room temperature for about 5 days and 14 days in the refrigerator.

An essential factor is that freezing and thawing of raw pollen can be repeated without affecting its quality due to its low water content (8-10%) and the fact that it does not contain pathogenic bacteria.

Freshly frozen pollen retains its qualities for about two years after collection according to Dr Rawhi (2012).

Like any protein-rich food it loses its nutritive and curative qualities within a few days if not stored properly (Spulber et al., 2020).

Raw pollen is recognized as a food with some standardized qualities in countries such as Argentina or Switzerland (Codigo Alimentario Argentino, 1998, Buenos Aires, Argentina: La Canal y Asociados).

In Argentina, for example, the quality standards of raw pollen are well defined:

aerobic microbiological ones should not exceed ISO x 10° CFU/g, fungal 10° CFU/g without pathogenic microorganisms, moisture should not exceed 8%, pH between 4 and 6, protein content should be approx. 15-28% Kjeldahal (N x 6.25) weight of dry pollen (Method developed by Johan Kjeldahl).

Raw pollen must be free of impurities, foreign bodies.

Raw pollen is analyzed in specialized laboratories, the most commonly used being to determine its vegetable origin.

In an article (Spulber et al., 2020) it was pointed out the need for a study at the whole geographical area of Romania in order to identify the type of monofloral pollen and the characteristics of its antioxidant properties.

The biological quality of raw pollen collected by bees is closely related to its plant origin, nutritional quality, nitrogen content and chemical composition.

Physical properties are understood to mean the ovoid or spherical shape of a pollen grain which is about 20-40 microns in diameter and has two envelopes called exine and intine.

The color of the raw pollen indicates its plant origin or geographical area, ranging from golden yellow to black.

Identification of raw pollen is based on morphological characteristics examined with a scanning electron microscope (SEM) and screening of phenolic compounds of raw pollen collected by bees is performed using the capillary electrophoresis method.

Raw pollen samples were collected from bee colonies in the stationary hive. From each type of pollen samples were collected and stored in individual containers at -18°C (Spulber et al., 2020).

However, taking into account the variable composition of raw pollen, one of the important

biological activities is its antioxidant activity (Freire et al., 2012).
Many studies have reported a positive correlation between antioxidant activity and the total phenolic content occurring in the composition of raw pollen collected by bees (Domenici et al., 2015).
The flavonoid content of raw bee-collected pollen can be up to 2.5% being mainly found as glycosides. Kaempferol derivatives, apigenin, luteolin and quercetin derivatives have been detected in raw pollen. The most common phenolic acids found in raw pollen collected by bees include gluconic, chlorogenic and formic, lactic, butyric acids and their derivatives.
Raw bee pollen is also rich in carotenoids and vitamins, including tocopherols and, in smaller quantities, calciferol. In addition, raw pollen collected from bees is a rich source of valuable macro and microelements for the human body (Kocot et al., 2018).
Biologically active compounds present in bee pollen include substances with different properties, e.g., phytosterols, organic acids and enzymes. Compounds possessing antibacterial properties include inhibins and phenolic acids, triterpenes and phytohormones (Pascoal et al., 2014).
Raw pollen collected by bees is a valuable source of vitamin E, which, due to its antioxidant properties, protects unsaturated fatty acids and some vitamins against oxidation.
Raw bee pollen also contains quercetin, an antioxidant that reduces LDL cholesterol in the human body and also has anti-atherosclerotic properties (Denisow & Denisow-Pietrzyk, 2016).
Polyphenols play a significant role in detoxifying the human body after drug or alcohol intoxication. They inhibit the activity of enzymes that are responsible for the formation of inflammation. They also have an antibiotic effect on fungi and bacteria pathogenic to humans.
Raw pollen collected by bees has an anti-atherosclerotic effect as it reduces the content of total lipids, total cholesterol and triacylglycerides in blood serum and also reduces the aggregation capacity of platelets.
Pollen is also of high nutritional value and supplements deficiencies of exogenous vitamins, bio elements and aminoacids (Kocot et al., 2018).
An interesting theory is the identification of resveratrol in raw pollen found in the *Brassica* sp. and in the methanolic extract from raw pollen of *Papaver* spp. Pollen type and luteolin has been identified in high amounts in *Papaver* spp. (Thakur & Nanda, 2020) also reported the presence of resveratrol in different *Brassica* species.
Antimicrobial activity of raw pollen collected by bees has been studied and it has been demonstrated by scientific work that raw monofloral pollen and also raw polyfloral pollen has clear antitumor, immunostimulatory action (Basim et al., 2006; Carpes et al., 2007).

POLLEN RESEARCH AS AN ANTIOXIDANT

According to research by Spulber et al. (2020). 45% of the raw pollen collected by bees is predominantly a single type of raw pollen of floral origin.
Phenolic compounds are regarded as the major constituents of bee pollen responsible for antioxidant activity (Harif et al., 2017).
An important research study in determining the antioxidant potential of raw pollen samples collected by bees (Habryka et al., 2021) was conducted using an ethanol-water extract with an initial concentration equal to 0.2 g/mL. An appropriate amount of sample was dissolved in ethanol: water solution (1:1 v/v), centrifuged (3000 x g; 15 min) and filtered through filter paper. The analysis was performed on a UV-Vis V-630 spectrophotometer (Jasco, Tokyo, Japan).
Research on raw pollen by Habryka et al. (2021), revealed the impact of raw pollen addition on the sensory characteristics of honey. Its color, odor, texture, and taste were evaluated. The mean results of the polyfloral honey colour assessment sensory descriptors were analysed to estimate colour: brightness, clarity, cloudiness, and uniformity. Polyfloral honey was designated as very golden, clear, and very uniform when mixed with pollen (Spulber et al., 2020.)
Furthermore, the analysis carried out did not reveal differences in texture and increasing the addition of raw pollen collected by bees to the honey reduced its brightness. Already an addition of 5% raw pollen collected by bees reduced honey brightness to an average value of

3.07, and with the addition of 25% raw pollen collected by bees, honey brightness was reduced to a level of 1.21 (Spulber et al., 2017).

The addition of pollen also reduced honey uniformity, clarity, and brightness.

In honey samples with added pollen, color uniformity was good and differences between the specimens for honey samples with different amounts of added bee pollen were small.

Raw pollen is considered a complete food, a valuable hive product, and, due to its composition, it can be transformed into a protein food and a complex nutrient (Kouchner et al., 2019). Raw pollen contains most of the vital elements of the human body. It acts in an absolutely miraculous natural synergy with the body, this synthesis cannot be artificially reproduced in the laboratory.

Based on the research work of Spulber et al. (2020) concluded the following hypothesis the pharmacological properties of pollen are different due to the potential source of over 1000 different flowers.

The most important properties of raw pollen, according to scientific research are: antibacterial, anti-inflammatory, antibiotic, antioxidant, antitoxic, aphrodisiac, allergy, anabolic, antisclerotic, antidepressant, antipyretic, diuretic, lowers LDL cholesterol in the blood, reduces the risk of genetic diseases, raw pollen is tonic, hepatoprotective, regulates hormones, is adjuvant against the negative effects of chemotherapy, is beneficial for the prostate (Donadieu, 1981).

Many medical researches, as well as some scientific research works have shown that pollen administered daily performs decongestive actions in various stages of prostate hypertrophy, ensuring preventive effects of prostatism (Donadieu, 1981) in elderly people.

According to Donadieu (1981), reliable results can be obtained by continuous daily administration of two tablespoons of raw pollen.

According to the study carried out by Spulber et al. (2020) raw pollen contains plant pigments, in particular flavonoids which in combination with vitamins C and E become a powerful reducer of free radicals determining the development of atherosclerosis and cardiovascular diseases. Flavonoids in pollen increase the collagen-storing action of vitamin C. (Teixeira et al., 2007).

According to the studies conducted by Dan et al. (2018) for a pollen harvest without *Nosema* spp. spores at the beginning of the winter season of bee families is important the source of honeycomb with food reserve. Examination of *Nosema* spp. spores presence in the food reserve before the winter makes it possible to remove (eliminate) from consumption these sources of infestation, which significantly decreases the morbidity and mortality rate among bees.

CONCLUSIONS

This paper is a summary of previous research on the impact of enriching the daily diet with raw pollen.

By adding raw pollen to the daily diet research studies have shown an increase in the phenolic content leading to an increase in antiradical and antioxidant activities.

A natural and fresh preparation can be a novelty for the end consumer, for the treatment of certain diseases or as a nutritional supplement, it can be a future research topic with favorable implications for a number of fields such as environmental protection, industry, apitherapy.

Romania has a great beekeeping and beekeeping potential, by encouraging and specializing young farmers with financial and informational support, this type of product with added raw pollen collected by bees can be made for the natural apitherapy food industry.

The key to a healthy lifestyle is a reorientation towards nature, a minimum care for the environment, an exceptional care for health through the quality of the products consumed, with a rich nutritional value.

ACKNOWLEDGEMENTS

This research work was carried out with the support of the Doctoral School - Engineering and Management of Plant and Animal Resources, Biotechnologies field, from the Faculty of Biotechnologies of the University of Agronomic Sciences and Veterinary Medicine, Bucharest.

REFERENCES

Abramovic, H., & Abram, V. (2005). Physico-chemical properties, composition and oxidative stability of Camelina sativa oil. *Food technol. biotechnol*, *43*(1), 63-70.

Asociația crescătorilor de albine, Institutul de cercetare și dezvoltare pentru apicultură, *Manualul cursantului Ediția I - 2012*, Editura LVS Crepuscul.

Axel, D., Cedric, A., Jean-Francois, O., Mickael, H., Bernard, V.E. (2011). *Why enhancement of floral resources in agro-ecosystems benefit honeybees and beekeepers?* In: Grillo, O. (Ed.), Ecosystems Biodiversity. InTech, Rijeka, Croatia.

Basim, E., Basim, H., & Özcan, M. (2006). Antibacterial activities of Turkish pollen and propolis extracts against plant bacterial pathogens. *Journal of food engineering*, *77*(4), 992-996.

Berti, M., Gesch, R., Eynck, C., Anderson, J., & Cermak, S. (2016). Camelina uses, genetics, genomics, production, and management. *Industrial crops and products*, *94*, 690-710.

Canadian Food Inspection Agency (CFIA) (2012). *Addendum II: Terms and Conditions for Confined Research Field Trials of Camelina* (*Camelina sativa*). Retrieved from https://inspection.canada.ca/plant-varieties/plants-with-novel-traits/approved-under-review/field-trials/terms-and-conditions/camelina/eng/1384464422223/1384464422879.

Carpes, S. T., Begnini, R., Alencar, S. M. D., & Masson, M. L. (2007). Study of preparations of bee pollen extracts, antioxidant and antibacterial activity. *Ciência e agrotecnologia*, *31*(6), 1818-1825.

Codigo Alimentario Argentino, 1998, Buenos Aires, Argentina: La Canal y Asociados.

Dan, B., Vasilică, S., Sapcaliu, A., Ion, R., Gabriela, M., Tănase Petruț V. C., & Ștefania, P. C. (2018). The prophylaxis of Nosema disease in bees by laboratory methods-microscopic testing of the beehive products. *Romanian Biotechnological Letters*, *23*(3), 13708.

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

Domenici, V., Gabriele, M., Parri, E., Felicioli, A., Sagona, S., Pozzo, L., ... & Pucci, L. (2015). Phytochemical composition and antioxidant activity of Tuscan bee pollen of different botanic origins.

Donadieu Y. (1981) - *Propolis in Natural Therapeutics* (France) – Maloine Editeur S.A., Paris, 2.

Eberle, C. A., Thom, M. D., Nemec, K. T., Forcella, F., Lundgren, J. G., Gesch, R. W., ... & Eklund, J. J. (2015). Using pennycress, camelina, and canola cash cover crops to provision pollinators. *Industrial Crops and Products*, *75*, 20-25.

FAO (2022). FAO Liaison Office in New York, Bees and other pollinators finally have the place they deserve, says Slovenian Deputy Prime Minister. Retrieved from https://www.fao.org/new-york/news/detail/en/c/1140945.

Faure, J. D., & Tepfer, M. (2016). Camelina, a Swiss knife for plant lipid biotechnology. *OCL*, *23*(5), D503.

Feás, X., & Estevinho, M. L. (2011). A survey of the in vitro antifungal activity of heather (*Erica sp.*) organic honey. *Journal of medicinal food*, *14*(10), 1284-1288.

Feás, X., Vázquez-Tato, M. P., Estevinho, L., Seijas, J. A., & Iglesias, A. (2012). Organic bee pollen: botanical origin, nutritional value, bioactive compounds, antioxidant activity and microbiological quality. *Molecules*, *17*(7), 8359-8377.

Francis-Baker, T. (2021). *Bees and Beekeeping* (No. 883). Bloomsbury Publishing.

Freire, L. L., Arezes, P. M., & Campos, J. C. (2012). A literature review about usability evaluation methods for e-learning platforms. *Work*, *41*(Supplement 1), 1038-1044.

Giampieri, F., Quiles, J. L., Cianciosi, D., Forbes-Hernández, T. Y., Orantes-Bermejo, F. J., Alvarez-Suarez, J. M., & Battino, M. (2022). Bee Products: An Emblematic Example of Underutilized Sources of Bioactive Compounds. *Journal of agricultural and food chemistry*. Retrieved from https://doi.org/10.1021/acs.jafc.1c05822.

Habryka, C., Socha, R., & Juszczak, L. (2021). Effect of bee pollen addition on the polyphenol content, antioxidant activity, and quality parameters of honey. *Antioxidants*, *10*(5), 810.

Harif Fadzilah, N., Jaapar, M. F., Jajuli, R., & Wan Omar, W. A. (2017). Total phenolic content, total flavonoid and antioxidant activity of ethanolic bee pollen extracts from three species of Malaysian stingless bee. *Journal of Apicultural Research*, *56*(2), 130-135.

Ialomiteanu, M. (1976). *Polenul, aliment – medicament valoare biostimulentă și terapeutică*, Editura Apimondia, București.

Ilieșiu N.V. (1991). *Apilarnilul – o nouă sursă apicolă de materii prime biologic active în folosul sănătății omului. Studiu tehnico - economic*, Editura Apimondia București, pp. 206 – 207.

Juríčková, Z., Lušňáková, Z., Hallová, M., Horská, E., & Hudáková, M. (2020). Environmental impacts and attitudes of agricultural enterprises for environmental protection and sustainable development. *Agriculture*, *10*(10), 440.

Kleftodimos, G., Gallai, N., Rozakis, S., & Képhaliacos, C. (2021). A farm-level ecological-economic approach of the inclusion of pollination services in arable crop farms. *Land Use Policy*, *107*, 105462.

Kocot, J., Kiełczykowska, M., Luchowska-Kocot, D., Kurzepa, J., & Musik, I. (2018). Antioxidant potential of propolis, bee pollen, and royal jelly: Possible medical application. *Oxidative medicine and cellular longevity*, *2018*.

Kolayli, S., & Keskin, M. (2020). Natural bee products and their apitherapeutic applications. *Studies in Natural Products Chemistry*, *66*, 175-196.

Kouchner, C.; Ferrus, C.; Blanchard, S.; Decourtye, A.; Basso, B.; Le Conte, Y.; Tchamitchian, M. (2018). *Sustainability of beekeeping farms: Development of an assessment framework through participatory research. In Proceedings of the 13th European International Farming Systems Association (IFSA) Symposium, Farming Systems: Facing Uncertainties and Enhancing Opportunities*, Crete, Greece, 1–5 July 2018; pp. 1–14.

Kouchner, C., Ferrus, C., Blanchard, S., Decourtye, A., Basso, B., Le Conte, Y., & Tchamitchian, M. (2019). Bee farming system sustainability: An assessment framework in metropolitan France. *Agricultural Systems*, *176*, 102653.

MADR, 2022. Organic agriculture. 212 Retrieved from https://www.madr.ro/docs/agricultura/agricultura-ecologica/2022/Regulamentul-2119-2021-registre-declaratii-eliberare-certificat.pdf.

Martinello, M., Manzinello, C., Dainese, N., Giuliato, I., Gallina, A., & Mutinelli, F. (2021). The honey bee: an active biosampler of environmental pollution and a possible warning biomarker for human health. *Applied Sciences*, *11*(14), 6481.

Martinello, M., & Mutinelli, F. (2021). Antioxidant activity in bee products: A review. *Antioxidants*, *10*(1), 71.

Pascoal, A., Rodrigues, S., Teixeira, A., Feás, X., & Estevinho, L. M. (2014). Biological activities of commercial bee pollens: Antimicrobial, antimutagenic, antioxidant and anti-inflammatory. *Food and Chemical Toxicology*, *63*, 233-239.

Pocol, C. B., Šedík, P., Brumă, I. S., Amuza, A., & Chirsanova, A. (2021). Organic beekeeping practices in Romania: Status and perspectives towards a sustainable development. *Agriculture*, *11*(4), 281.

Rahimi, M. K., Abbasi, E., Bijani, M., Tahmasbi, G., & Azimi Dezfouli, A. A. (2020). Sustainability criteria of apicultural industry: Evidence from Iran. *Ecosystem Health and Sustainability*, *6*(1), 1818630.

Rawhi M.A.A. (2012). *Totul despre apiterapie*, Editura All, București.

Séguin-Swartz, G., Eynck, C., Gugel, R. K., Strelkov, S. E., Olivier, C. Y., Li, J. L., ... & Falk, K. C. (2009). Diseases of *Camelina sativa* (false flax). *Canadian Journal of Plant Pathology*, *31*(4), 375-386.

Spulber, R., Colța, T., Băbeanu, N., & Popa, O. (2017). Chemical diversity of polyphenols from bee pollen and propolis. *AgroLife Scientific Journal*, *6*(2), 183-194.

Spulber, R., Popa V., & Băbeanu N. (2020). Flavonoid /Phenolic Profile and Antioxidant Activity of Raw Monofloral Be Pollen from South Romania, *AgroLife Scientific Journal*, 9(2), 305-312.

Teixeira, S., Mendes, A., Alves, A., & Santos, L. (2007). Simultaneous distillation–extraction of high-value volatile compounds from *Cistus ladanifer* L. *Analytica Chimica Acta*, *584*(2), 439-446

Thom, M. D., Eberle, C. A., Forcella, F., Gesch, R., Weyers, S., & Lundgren, J. G. (2016). Nectar production in oilseeds: food for pollinators in an agricultural landscape. *Crop Science*, *56*(2), 727-739.

Thakur, M., & Nanda, V. (2020). Composition and functionality of bee pollen: A review. *Trends in Food Science & Technology*, *98*, 82-106.

Tomczyk, M., Miłek, M., Sidor, E., Kapusta, I., Litwińczuk, W., Puchalski, C., & Dżugan, M. (2019). The effect of adding the leaves and fruits of Morus alba to rape honey on its antioxidant properties, polyphenolic profile, and amylase activity. *Molecules*, *25*(1), 84.

Zawislak, J., Adamczyk, J., Johnson, D. R., Lorenz, G., Black, J., Hornsby, Q., ... & Joshi, N. (2019). Comprehensive survey of area-wide agricultural pesticide use in Southern United States row crops and potential impact on honey bee colonies. *Insects*, *10*(9), 280.

Zubr, J. (1997). Oil-seed crop: *Camelina sativa*. *Industrial crops and products*, *6*(2), 113-119.

Walsh, E. M., Janowiecki, M. A., Zhu, K., Ing, N. H., Vargo, E. L., & Rangel, J. (2021). Elevated mating frequency in honey bee (Hymenoptera: Apidae) queens exposed to the miticide amitraz during development. *Annals of the Entomological Society of America*, *114*(5), 620-626.