

Exploring the nutritional value of fresh bee pollen from different Belgian areas

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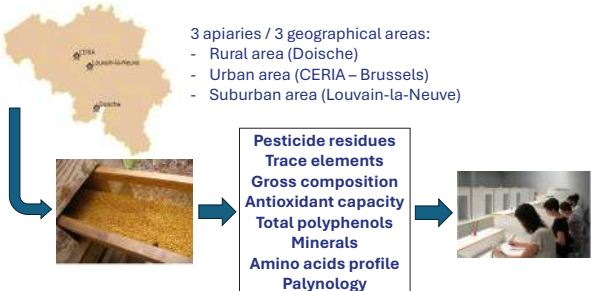
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Introduction

Despite its potential as a promising area of growth for beekeepers, the valorisation of bee products other than honey is limited in Belgium. Bee pollen is widely available in this country, is easy to collect and could contribute to the local economy. However, the nutritional value and safety of Belgian bee pollen must be investigated, as well as its stability despite geographical and seasonal variables.

For two years, the main objective of this research was to characterise fresh bee pollen samples (i.e. not dried) collected monthly from three Belgian apiaries located in distinct geographical areas, regarding nutritional quality, but also safety aspects, botanical origin and sensory properties.

Materiel & Methods



Results

1. Contaminants & Toxicity

Screening of > 300 pesticide residues (GC-MS & LC-MS/MS)

- 2023 → 1 herbicide in the suburban sample (< MRL)
- 2024 → 2 fungicides and 1 herbicide in the rural sample (< MRL), but presence of 1 fungicide (Fluopyram) > MRL (0.057 mg/kg) !

Trace elements (ICP-AES)

- Higher Pb concentrations in urban area ; < LOQ in rural area ;
- As, Pd, Sb and Sn always < LOQ ;
- Presence of Al, Co and Ni but no norms available for bee pollen.

2. Gross composition

The gross composition reported to dry weight did not differ significantly between geographical areas (Fig. 1) or between years and seasons. However, variable moisture contents were observed, probably associated to the different types of pollen traps used during the study (Romanian vs. RG trap).

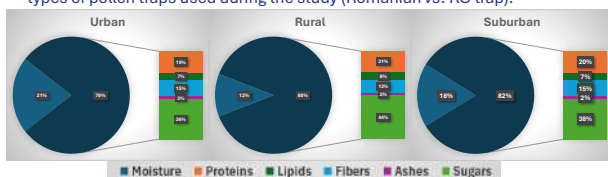


Fig. 1 - Influence of type of environment on gross composition.

3. Focus on specific nutritional properties

The nutritional properties of bee pollen were also investigated, including its antioxidant capacity and polyphenols content, amino acids profile and minerals concentration. High antioxidant capacity was observed, associated with polyphenols content of around 4 mg of gallic acid equivalent per g of pollen. No significant influence of localisation was observed (Fig. 2A), but polyphenols levels tended to decrease during the year (Fig. 2B).

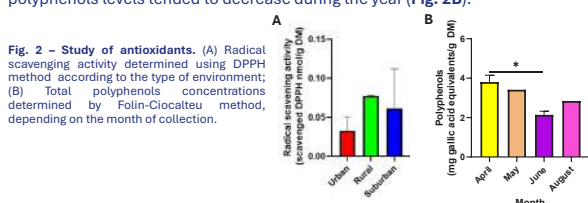


Fig. 2 - Study of antioxidants. (A) Radical scavenging activity determined using DPPH method according to the type of environment; (B) Total polyphenols concentrations determined by Folin-Ciocalteu method, depending on the month of collection.

On average, all the samples were a good source of all the essential amino acids, with profiles that remained almost constant throughout the year and between apiaries (Fig. 3A). Daily consumption of 10 g of pollen could significantly contribute to dietary requirements for essential amino acids (Fig. 3B).

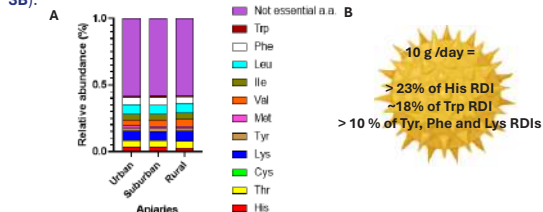


Fig. 3 - Amino acids composition of Belgian bee pollen. (A) Amino acids profiles by geographical area, determined by HPL-UV after protein hydrolysis and amino acids derivatization ; (B) Part of the recommended dietary intake (RDI) potentially supplied by the consumption of 10 g of pollen per day.

4. Palynology and Sensory analysis

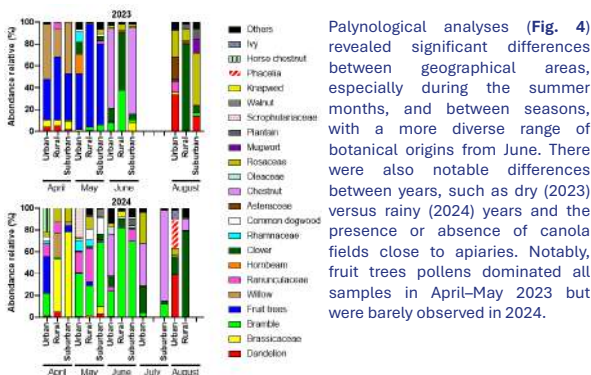


Fig. 4 - Botanical origins of all bee pollen samples determined by optical microscopy.

A quantitative sensory analysis was performed by 15 judges. During pre-sessions, more than 20 attributes were identified, focusing on colour, taste, aromas, texture and aftertaste. Interestingly, data analysis highlighted three groups of correlated attributes (Fig. 5): (a) Colourful, sweet and acidic pollens with a fruity aroma, (b) Green bitter pollens with chemical and plant aromas, and (c) Yellow pollens with intense floral and honey aromas.

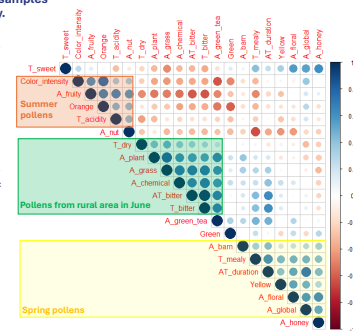


Fig. 5 - Correlation between sensory attributes. Blue and red bullets indicate positive and negative correlations between two descriptors, respectively ; T, A and AT are attributes related to texture, aromas and aftertaste, respectively.

Conclusions & Perspectives

This study confirmed the nutritional interest of Belgian bee pollen, which is a good source of proteins with a high-quality amino acids profile. It is also rich in polyphenols, which confer antioxidant properties. Furthermore, while most samples are free from major contamination, monitoring the presence of pesticide residues remains important.

In the next years, it would be interesting to continue this work in order to confirm the trends observed during this two-year study, particularly the progressive decrease in polyphenols concentrations over the course of a year, and to attempt to link sensory attributes to the botanical origins of pollens. The actual bioavailability of nutrients also remains to be investigated, as does the absence of any cytotoxic effect on human intestinal cells.

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Apitherapy is a critical opportunity for beekeepers aiming to valorize bee products other than honey. Bee pollen has been consumed as healthy food for a long time in Romania, but also in Australia, Argentina and China. Its nutritional qualities include a high protein content and antioxidant potential, and interesting concentrations of vitamins and minerals. These properties depend on geographical and botanical origin and on seasonality. Pollen conditioning, i.e. drying or freeze-drying, also impacts final properties. In Western countries, including Belgium, consumption of bee pollen remains marginal. To promote the product, it is essential to demonstrate its healthy properties at a local level.

For two years, bee pollen was collected monthly from three apiaries in Belgian urban, suburban and rural areas. Samples were directly stored at -18°C upon arrival at the laboratory. Health-promoting factors studied were: (a) proteins and amino acid profiles, (c) antioxidant potential and total polyphenols, (d) minerals, (e) absence of unacceptable levels of pesticides and trace elements and (f) absence of cytotoxicity. Botanical origin of samples was also determined.

Due to distinct meteorological conditions in 2023 and 2024, pattern of pollen botanical origin identified the first year was not observed the second year. However, the phenomenon did not affect pollen characteristics. Overall, protein content was always between 23 and 27 g/100 g of dry pollen. Pesticide residues were barely observed (respectively 1 and 4 molecules in 2023 and 2024) and generally below MRLs. Health promoting characteristics of pollen were never influenced by the area of sampling, contrary to seasonal pattern. Indeed, pollens from August always had lowers polyphenol concentrations. Amino acid profiles were also modified in August, but all essential amino acids were still present. Overall, the growth of CaCo2 cells was never affected by pollen during MTT assays, and some samples even showed a growth-promoting activity.

Globally, this work confirmed the high potential of Belgian bee pollen in apitherapy or as food ingredient.