

Comparative Spectroscopic Analysis of Bee Propolis: NIR, FT-IR, FT-Raman and ¹H NMR.

Focus on Provenance and Antioxidative Correlation

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Background

Propolis is a polyphenol-rich, resinous substance produced by honey bees. It is widely recognized for its antioxidative activity, mainly attributed to its high content of aromatic polyphenols.

Aim

To compare the chemical composition and antioxidative activity of propolis from Australia, Denmark, and Norway using untargeted spectroscopic methods, and to predict radical scavenging activity (RSA) using multivariate models.

Experimental

Propolis samples (N = 53) from Australia (8), Denmark (38), and Norway (7) were analyzed using IR, Raman, and NIR spectroscopy on raw material, and ¹H NMR on chloroform extracts. The latter is not shown in this poster. Radical scavenging activity (RSA) was measured using a colorimetric assay. Data were evaluated by Principal Component Analysis (PCA), correlation analysis, and Partial Least Squares (PLS) regression to explore composition and predict RSA.

Results

PCA showed Danish and Norwegian samples contained more aromatic compounds, while Australian samples had higher levels of carbohydrates and terpenoids. RSA was significantly lower in Australian samples ($p < 0.001$). NIR-based PLS models predicted RSA with the highest accuracy ($R^2 = 0.75$, RMSECV = 6.66%).

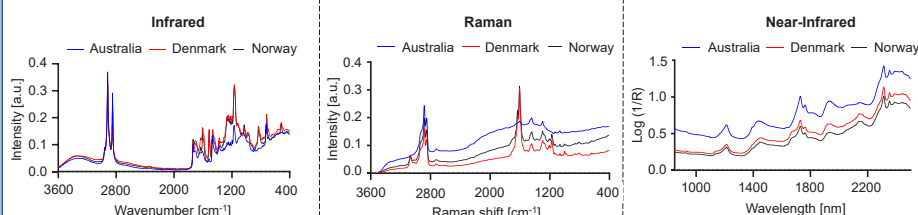
Conclusion

Untargeted spectroscopic methods effectively profiled propolis composition and predicted antioxidative activity. Scandinavian propolis showed higher RSA, likely due to increased aromatic polyphenol content. NIR spectroscopy proved most accurate for RSA prediction.

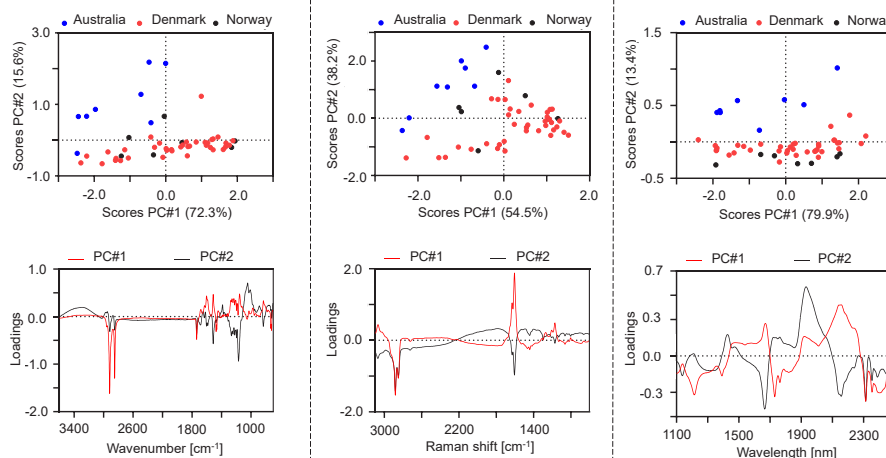
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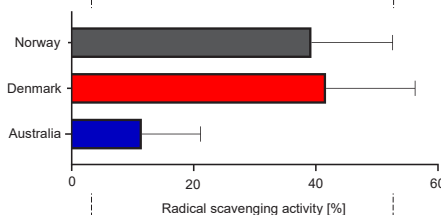
Step 1: Analyse propolis samples using spectroscopy



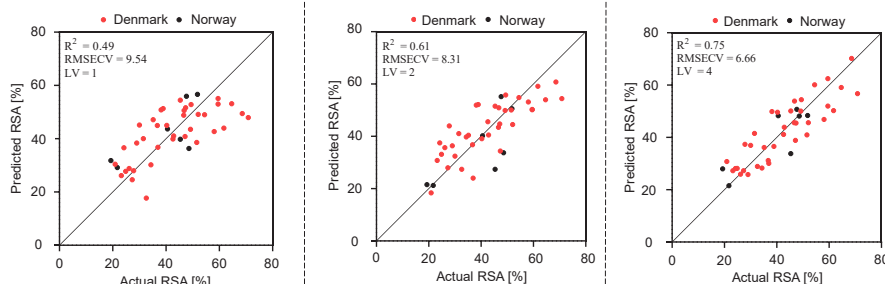
Step 2: Compare chemical composition using PCA



Step 3: Measure radical scavenging activity of propolis samples



Step 4: Predict radical scavenging activity based on spectroscopic data



PP-350 [Apitherapy]
Comparing Propolis from Different Bee Species and Regions Using ¹H NMR Spectroscopy

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Background & Purpose

Propolis is a resinous substance produced by bees that protects the hive and defends against disease. While its composition varies by geographic origin, less is known about how different bee species affect its chemical makeup.

Problem description

This study uses proton nuclear magnetic resonance (¹H NMR) spectroscopy to compare the chemical profiles of propolis from different bee species. It aims to provide insights into species-specific propolis production and its functional properties.

Methodology

Propolis samples were collected from local beekeepers. The samples included propolis from *Apis mellifera* (*A. mellifera*) colonies in Denmark, Norway, and Australia, as well as from *Tetragonula carbonaria* (*T. carbonaria*) colonies in Australia. A two-phase extraction method (methanol–water and chloroform) separated the samples into aqueous and lipid phases, followed by ¹H NMR spectroscopy. Correlation analysis and principal component analysis (PCA) were used to assess chemical variations among samples.

Results & CONCLUSION: Scandinavian *A. mellifera* propolis contained higher polyphenol levels, while propolis from both Australian bee species had more carbohydrates. Additionally, *T. carbonaria* propolis had shorter, less functionalized wax chains than *A. mellifera* propolis and a higher terpenoid content. These findings demonstrate that both geographic origin and bee species significantly influence the chemical composition of propolis, highlighting species-specific adaptations in resin foraging and biosynthesis.

Practical Implications for beekeepers

¹H NMR spectroscopy enables the rapid identification of propolis variants suitable for pharmaceuticals, nutraceuticals, and cosmetics. Identifying species-specific propolis profiles enables beekeepers to refine harvesting strategies and target propolis with desirable bioactive properties. Spectroscopy also serves as a quality control tool to ensure consistency in commercial propolis products.