Clustering analysis of honey samples from Indian Ocean islands computed from near infrared data

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Introduction

Bee keepers on several islands of the Indian Ocean are desirous of a protected designation of origin for their honey. Unfortunately, little data is available on the diversity of honey in this region, which is considered a hotspot of floral biodiversity. Given the high costs of classical analysis, NIR spectroscopy has been implemented to develop a classification method for honey provenance and botanical origin. The objectives of this study were to create a NIR spectral database of honey produced on islands in the Indian Ocean, and in Europe, and to underline the diversity of honey samples through a clustering analysis of NIR as a preliminary appraisal for regional and botanical classification.

Materials and Methods

Samples

The sample set (n = 291) investigated comprised honey samples from different floral origins, namely litchi (n = 35), eucalyptus (n = 32), rose pepper (n = 28), polyfloral and forest (n = 68) and other floral origins (n = 104); and from 5 geographical origins namely, Madagascar (n = 74), Mauritius and Rodrigues Island (n = 63), Comoros (n = 8), Reunion Island (n = 95), and countries in Europe (n = 51).

Near infrared spectrometry

Samples were scanned from 1100–2498 nm in transflectance mode at 2 nm intervals in a monochromator (FOSS NIRSystems 5000, Silver Springs, MD, USA). Spectral data were investigated after second derivative transformation and mathematical pretreatment (smoothing 5, gap 5). Clustering analysis computed from NIR data was performed using principal component analysis (PCA), and ascending hierarchical clustering (HAC).

Results and Discussion

Outliers (n = 6) were identified as adulterated honey products mainly produced in Mauritius and Rodrigues; 5 other honey samples from Mauritius and Madagascar had spurious spectral profiles and, in lack of secondary investigations, were discarded. With the 280 remaining honey samples, PCA and HAC defined 6 clusters from the spectral data, which were defined as follows.

Cluster 1 featured 61% of eucalyptus honeys from Madagascar (n = 8), 40% of eucalyptus honeys from Rodrigues (n = 12), 70% of forest honeys from Reunion (n = 9), 66% of rosewood honeys from Madagascar (n = 4), every loquat (*Eriobotrya japonica*) and jujube (*Ziziphus sp*.) honey from Reunion, and all honeys produced in Comoros (n=8).

Cluster 2 included the major part of European acacia, rapeseed, heather, chestnut, and rosemary honeys (n = 16). 50% of baobab (n = 2), litchi (25%; n = 4), and polyfloral honeys (50%; n = 11) from Madagascar are also clustered in this second group.

Cluster 3 included French fir and forest honeys (83%; n = 6 samples). Correlation with high conductivity is still under study.

Cluster 4 gathered European monofloral honeys of thyme, linden, dandelion, buckthorn and raspberry. Also featured were honeys of rose pepper, jamrose and palm tree from Reunion (confirmed with palynology), and 30% of eucalyptus (n = 4), mokaragna, niaouli, rosewood from Madagascar; 85% of the unadulterated Mauritian honeys also belong to this fourth group. This group may cluster honeys produced in a forest context.

Cluster 5 was composed of litchi honeys from Madagascar and Reunion (n = 6). Additional studies are needed to interpret this specificity.

Cluster 6 mainly contained honeys from Reunion, Mauritius and Rodrigues (85%; n = 60 samples); it may discriminate a spectral family specific to products of polyfloral origin in an insular landscape with rose pepper, litchi, eucalyptus, citrus, tamarind and other local flowers.

Reference paper as:
V. Porphyre, S. Nabeneza and D. Bastianelli (2012).Clustering analysis of honey samples from Indian Ocean islands from near infrared data, in: Proceedings of the 15th International Conference on NearInfrared Spectroscopy,
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We note that rose peppers, litchis and eucalyptus honeys from the same origin were distributed in several clusters, which may indicate a large diversity within the same product's class and a possible mislabelling or a lack of knowledge of the floral origin. Clustering of honeys regarding their geographical origins was still unclear; however, this first clustering analysis gives the basic indications prior to a classification analysis of insular honeys in Indian Ocean.

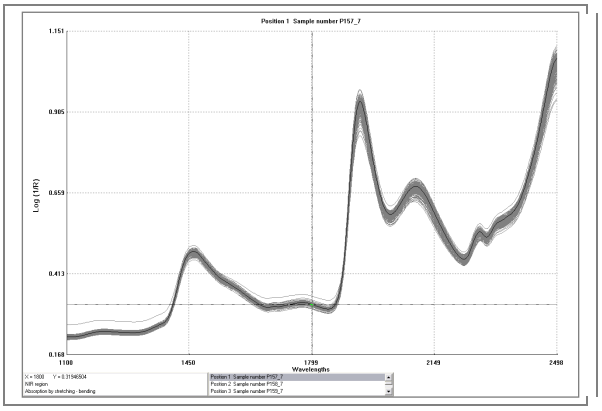

Figure 1. NIR transflectance spectra of honey samples (n = 291) collected during 2010–2011.

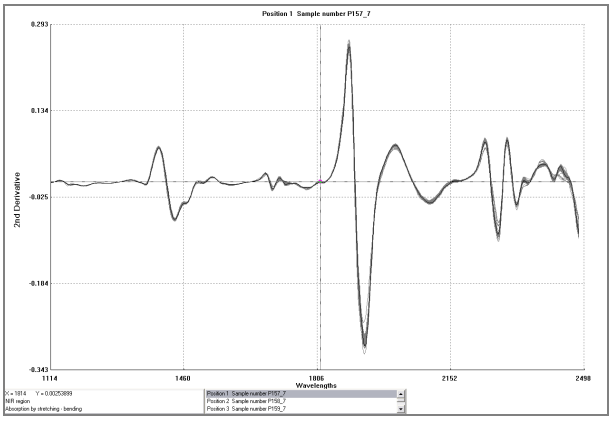

Figure 2. NIR transflectance spectra of our 291 honey samples after second derivative pretreatment.

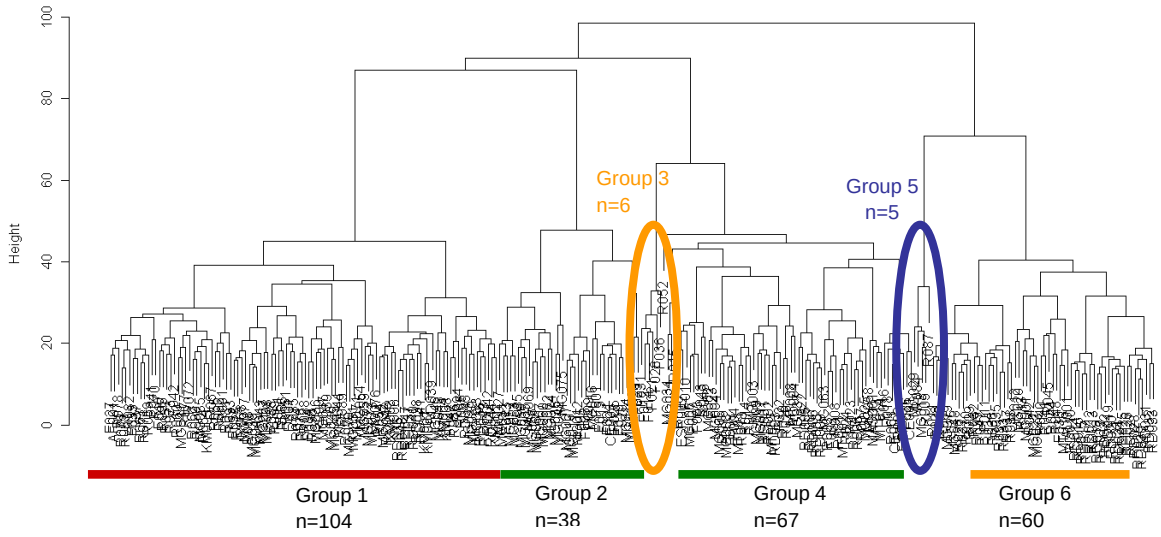

Figure 3. Dendrogram tree after Hierarchical Ascending Clustering on PCA scores.

Conclusion

Although it has previously been shown that the geographical and botanical origins of honeys can be detected by NIR spectroscopy, our preliminary results showed that the relationships between NIR data with geographical and floral origins are still unclear for honeys produced on islands in the Indian Ocean. Frequent adulterations and mislabelling for botanical origin are reported. Our NIR spectral library needs to be enlarged and completed with physico-chemical analysis and palynological analysis.

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gathers 33 institutions from Madagascar, Comoros, Mauritius and Rodrigues, Reunion and Seychelles. More details: www.qualireg.org

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