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Authentication of Egyptian blossom honeys

Twenty-two blossom honey samples (clover and citrus honeys) were collected from the greater Cairo area during harvesting year 2014-2015. The main purpose of the present study was to characterize the aforementioned honey types and to investigate whether the use of easily assessable physicochemical parameters, including colour attributes, in combination with chemometrics could differentiate honey floral origin. Parameters taken into account were: pH, electrical conductivity, ash, free acidity, lactonic acidity, total acidity (TA), moisture content, total sugars [Brix (°Bx)], total dissolved solids (TDS) and their ratio to total acidity, salinity, CIELAB colour parameters along with browning index values.

Eight selected significant physicochemical parameters values namely: L^*, a^*, TDS, salinity, moisture, FA, TA, TDS/TA were subjected to linear discriminant analysis (LDA). Results showed that one discriminant function (DF) was formed: Wilks' Lambda=0.204, X^2=25.418, df=8, $p<0.01$. The DF was used for the classification of Egyptian honeys according to floral origin, since it explained the 100% of total variance providing an eigenvalue of 3.897 and a good canonical correlation equal to 0.892. The overall correct classification rate was 95.5% for the original and 90.9% for the cross validation method.

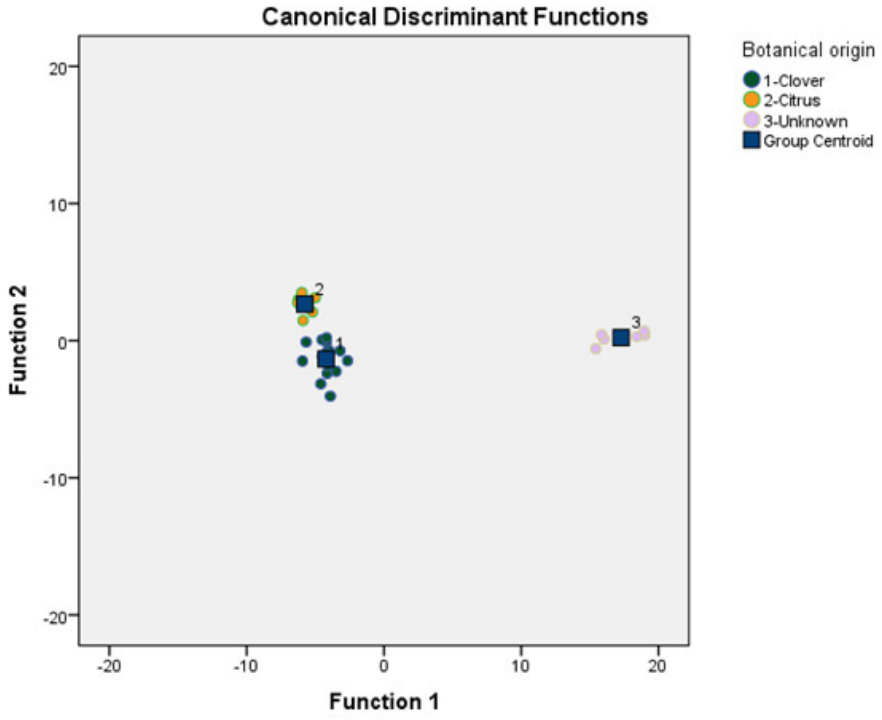

Fig. 1. Floral discrimination of clover and citrus honeys from Egypt against ''unknown'' honeys from Greece based on 11 easily assessable physicochemical parameters and discriminant analysis.

In order to investigate the robustness of the statistical model developed for the classification of clover and citrus honeys from Egypt, unpublished data involving specific physicochemical parameters of honeys from

Greece were introduced into the set of data and new statistical analysis was carried out. Honeys from Greece served as the ''unknown'' honey samples. The common physicochemical parameter values taken into account from our database were: moisture, free acidity, total sugars ($Brix^0$), browning index, pH, electrical conductivity, colour (L^*, a^*, b^*), TDS and salinity. Thus, these physicochemical parameters served as the independent variables while botanical origin (clover, citrus and unknown honeys) was taken as the dependent variable. The total number of honey samples was increased to 28 prior to discriminant analysis. Based on CIE colour parameter analysis, visual colour estimation, electrical conductivity and ash content values, the unknown honey samples from Greece could be classified as honeydew honeys.

LDA showed that two DFs were formed: Wilks' Lambda=0.003, X^2=121.611, df=20, $p<0.001$ for the first and Wilks' Lambda =0.246, X^2=28.774, df=9, $p=0.001$ for the second. However, DF1 was the basic one for the classification of Egyptian and unknown honeys according to floral origin, since it explained the 96.8% of total variance providing a high eigenvalue (91.630) and a high canonical correlation (0.995) in comparison with the DF2 (eigenvalue of 3.070 and canonical correlation of 0.869). Respective group centroid values, representing the discriminant functions at group means were: (-4.220, -1.334), (-5.766, 2.666), (17.277, 0.224), for clover, citrus and unknown honeys, respectively (Fig. 1).

In Figure 1 it is also shown that clover, citrus and unknown honeys are well differentiated. The overall correct classification rate was 100% for the original and 92.9% for the cross validation method, considered a very satisfactory discrimination rate for this method. The higher discrimination rate was provided for citrus (100%) followed by clover (93.3%) and unknown (83.3%) honeys.

Remarks:
All honey samples analyzed met the European quality standards set for honey and recorded variations in the aforementioned physicochemical parameters, depending on floral origin. Application of LDA showed that 8 physicochemical parameters could classify Egyptian honeys according to floral origin ($P<0.05$). The classification rate was 95.5% using the original and 90.9% the cross validation method. The discriminatory ability of the developed model was further validated using unknown honey samples. The overall correct classification rate was not affected. Specific physicochemical parameter analysis in combination with chemometrics has the potential to enhance the differences in floral honeys produced in a close geographical zone.

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