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Chemometric classification of several olive cultivars from Trás-os-Montes region (northeast of Portugal) using artificial neural networks

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ABSTRACT

This work aimed to use artificial neural networks for fruit classification according to olive cultivar, as a tool to guarantee varietal authenticity. So, 70 samples, each one containing, in general, 40 olives, belonging to the six most representative olive cultivars of Trás-os-Montes region (Cobrançosa, Cordovil, Madural, Negrinha de Freixo, Santulhana and Verdeal Transmontana) were collected in different groves and during four crop years. Five quantitative morphological parameters were evaluated for each fruit and endocarp, respectively. In total, ten biometrical parameters were used together with a multilayer perceptron artificial neural network allowing the implementation of a classification model. Its performance was compared with that obtained using linear discriminant analysis. The best results were obtained using artificial neural networks. In fact, the external validation procedure for linear discriminant analysis, using olive data from olive trees not included in the model development, showed an overall sensibility and specificity in the order of 70% and varying between 45 and 97% for the individual cultivars. On the other hand, the artificial neural network model was able to correctly classify the same unknown olives with a global sensibility and specificity around 75%, varying from 58 and 95% for each cultivar. The predictive results of the artificial neural network model selected was further confirmed since, in general, it correctly or incorrectly classified the unknown olive fruits in each one of the six cultivars studied with, respectively, higher and lower probabilities than those that could be expected by chance. The satisfactory results achieved, even when compared with previous published works, regarding olive cultivar's classification, show that the neural networks could be used by olive oil producers as a preventive and effective tool for avoiding adulterations of Protected Designation of Origin or monovarietal olive oils with olives of non-allowed cultivars.

1. Introduction

Olive oil and table olives are products with significant nutritional value and are important components of the Mediterranean diet. Its consumption is increasing in the world namely due to their benefits for health.

Olive oil production is mostly concentrated in the Mediterranean countries. In Portugal, the olive tree has an important economic, social and landscape role, being distributed almost throughout the entire territory, with special incidence in the interior land, namely in the region of Trás-os-Montes. The olive oil produced in this region is of excellent quality mainly due to their pedological characteristics and climatic conditions in association with traditional cultivars and cultural practices, which confer unique characteristics to the olives as well as to the olive oil produced. Its identity, genuineness and quality have been recognized by the European Union and the Protected Designation of Origin (PDO) "Azeite de Trás-os-Montes" was created. The allowed cultivars that can be used are the traditional cultivars Cobrançosa, Madural and Verdeal Transmontana. However other cultivars can be also included in a percentage lower than 10%. Due to its recognized high quality, "Azeite de Trás-os-Montes" is a high-valuable product attaining very high market prices, which favour adulterations using non-permitted olive cultivars. Furthermore, in the last years, monovarietal olive oil's production is also rising being, from the growers point of view, a practical way to differentiate and increase olive oil commercial value. In this context, a simple, secure and practical cultivar identification is required for assuring olive oil authenticity, namely in which concerns monovarietal and PDO olive oils.

In fact, the adulteration of PDO or monovarietal olive oils is quite frequent and so it is important to establish and validate easy and reliable methodologies that can be used for genuineness studies. Several analytical methods, namely FT-Raman spectroscopy, gas chromatography, high-performance liquid chromatography, electronic noses, near-infrared spectroscopy, nuclear magnetic resonance spectroscopy and isotope ratio mass spectrometry [1–9] have been

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