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Comprehensive analysis of oranges available for consumption in Portugal: A comparative study

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Citrus production in Portugal's Algarve region is a major economic activity, contributing to both local and national markets, with exports primarily to Europe. Algarve oranges are known for their high quality and distinct characteristics, shaped by the region's unique climate and geography. These oranges are often certified under the Protected Geographical Indication (PGI) "Citrinos do Algarve" that guarantees the origin and quality of citrus fruits produced in the Algarve region.[1] Although Algarve oranges are the most prominent, other types of oranges also reach consumers.

In this context, the objective of this work was to conduct a comparative study between five different varieties of oranges (Baía, Dalmau, Navelate, Lane Late and Salustiana) from various origins (production region, production method and marketplaces). This study employs a multifaceted approach, including physicochemical and sensory analyses, to evaluate and compare their quality. External characteristics like appearance, shape (dimensions), and color were assessed, along with physicochemical properties of the orange juice such as total solids (TS), density, total soluble solids (SS) (°Brix), titratable acidity (TA), the SS/TA ratio, and color - key indicators of the fruit's sweetness and quality. An untrained panel evaluated attributes like appearance, taste, sweetness, and acidity, providing a subjective but essential perspective on sweetness perception. Complementing these traditional techniques, the use of an electronic tongue (E-tongue) allowed for the detection of specific chemical patterns related to human sweetness perception, offering precise and repeatable analysis.

The results indicated that, except for the Dalmau variety, all tested varieties had satisfactory sensory acceptance, scoring above 4.2 on a 7-point scale (70% acceptance). Lane Late variety was the most appreciated by the untrained panel (consumer perception), excelling in both external characteristics and sensory attributes post-tasting. Physicochemical results corroborated these findings, with Lane Late showing the lowest pH value (3.53 ± 0.12), a titratable acidity of 0.50 ± 0.12 g citric acid/100 g, a soluble solids content of 12.14 ± 0.66 °Brix, and the highest SS/TA ratio of 22.99 ± 3.27, revealing the highest sweetness perception.

The E-tongue analysis identified distinct flavor profiles among the orange varieties. Potentiometric signals from the 40-lipid sensor membranes were used to develop a multivariate linear classification model to discriminate the 5 orange cultivars. A linear discriminant analysis (LDA) coupled with the simulated annealing (SA) variable selection algorithm established an LDA-SA-E-tongue classification model with a correct classification rate of 94.4%, indicating high effectiveness in classifying the different samples. The LDA model has 2 discriminant functions: DF1 explained 99.8% of the variability, and DF2 explained the remaining 0.10%, clearly separating the sample groups. The E-tongue's satisfactory predictive performance can be attributed to its capacity to discriminate basic tastes and their intensities, namely sweet and acid gustatory sensations.

By integrating these methods, a comprehensive profile of the sweetness of oranges available in Portugal was obtained and compared both objectively and subjectively, highlighting the excellence or unique characteristics of the Algarve region's oranges, especially the PGI-classified Lane Late variety. This variety had an average diameter of 87.41 ± 3.76 mm, second only to the Baía variety, which had an average diameter of 92.14 ± 5.40 mm. Its peel thickness was intermediate among the varieties studied, measuring 5.27 ± 0.58 mm. Although the total solids content of the Lane Late variety reached 12.01 ± 0.72%, close to the Navelate variety at 12.62 ± 1.49%, it had the lowest ash content of all the varieties (0.38 ± 1.13).

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