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Comparison of Artificial Neural Networks and Statistical Classifiers in Olive Sorting Using Near-Infrared Spectroscopy

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Abstract : Table olive is a valuable product especially in Mediterranean countries. It is usually consumed after some fermentation process. Defects happened naturally or as a result of an impact while olives are still fresh may become more distinct after processing period. Defected olives are not desired both in table olive and olive oil industries as it will affect the final product quality and reduce market prices considerably. Therefore it is critical to sort table olives before processing or even after processing according to their quality and surface defects. However, doing manual sorting has many drawbacks such as high expenses, subjectivity, tediousness and inconsistency. Quality criterions for green olives were accepted as color and free of mechanical defects, wrinkling, surface blemishes and rotting. In this study, it was aimed to classify fresh table olives using different classifiers and NIR spectroscopy readings and also to compare the classifiers. For this purpose, green (Ayvalik variety) olives were classified based on their surface feature properties such as defect-free, with bruised defect and with fly defect using FT-NIR spectroscopy and classification algorithms such as artificial neural networks, ident and cluster. Bruker multi-purpose analyzer (MPA) FT-NIR spectrometer (Bruker Optik, GmbH, Ettlingen Germany) was used for spectral measurements. The spectrometer was equipped with InGaAs detectors (TE-InGaAs internal for reflectance and RT-InGaAs external for transmittance) and a 20-watt high intensity tungsten–halogen NIR light source. Reflectance measurements were performed with a fiber optic probe (type IN 261) which covered the wavelengths between 780–2500 nm, while transmittance measurements were performed between 800 and 1725 nm. Thirty-two scans were acquired for each reflectance spectrum in about 15.32 s while 128 scans were obtained for transmittance in about 62 s. Resolution was 8 cm^{-1} for both spectral measurement modes. Instrument control was done using OPUS software (Bruker Optik, GmbH, Ettlingen Germany). Classification applications were performed using three classifiers; Backpropagation Neural Networks, ident and cluster classification algorithms. For these classification applications, Neural Network tool box in Matlab, ident and cluster modules in OPUS software were used. Classifications were performed considering different scenarios; two quality conditions at once (good vs bruised, good vs fly defect) and three quality conditions at once (good, bruised and fly defect). Two spectrometer readings were used in classification applications; reflectance and transmittance. Classification results obtained using artificial neural networks algorithm in discriminating good olives from bruised olives, from olives with fly defect and from the olive group including both bruised and fly defected olives with success rates respectively changing between 97 and 99%, 61 and 94% and between 58.67 and 92%. On the other hand, classification results obtained for discriminating good olives from bruised ones and also for discriminating good olives from fly defected olives using the ident method ranged between 75-97.5% and 32.5-57.5%, respectfully; results obtained for the same classification applications using the cluster method ranged between 52.5-97.5% and between 22.5-57.5%.

Keywords : artificial neural networks, statistical classifiers, NIR spectroscopy, reflectance, transmittance
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