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Edge Enhancement Visual Methodology for Fat Amount and Distribution Assessment in Dry-Cured Ham Slices

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Abstract : Dry-cured ham is an uncooked meat product particularly appreciated for its peculiar sensory traits among which lipid component plays a key role in defining quality and, consequently, consumers' acceptability. Usually, fat content and distribution are chemically determined by expensive, time-consuming, and destructive analyses. Moreover, different sensory techniques are applied to assess product conformity to desired standards. In this context, visual systems are getting a foothold in the meat market envisioning more reliable and time-saving assessment of food quality traits. The present work aims at developing a simple but systematic and objective visual methodology to assess the fat amount of dry-cured ham slices, in terms of total, intermuscular and intramuscular fractions. To the aim, 160 slices from 80 PDO dry-cured hams were evaluated by digital image analysis and Soxhlet extraction. RGB images were captured by a flatbed scanner, converted in grey-scale images, and segmented based on intensity histograms as well as on a multi-stage algorithm aimed at edge enhancement. The latter was performed applying the Canny algorithm, which consists of image noise reduction, calculation of the intensity gradient for each image, spurious response removal, actual thresholding on corrected images, and confirmation of strong edge boundaries. The approach allowed for the automatic calculation of total, intermuscular and intramuscular fat fractions as percentages of the total slice area. Linear regression models were run to estimate the relationships between the image analysis results and the chemical data, thus allowing for the prediction of the total, intermuscular and intramuscular fat content by the dry-cured ham images. The goodness of fit of the obtained models was confirmed in terms of coefficient of determination (R^2), hypothesis testing and pattern of residuals. Good regression models have been found being 0.73, 0.82, and 0.73 the R2 values for the total fat, the sum of intermuscular and intramuscular fat and the intermuscular fraction, respectively. In conclusion, the edge enhancement visual procedure brought to a good fat segmentation making the simple visual approach for the quantification of the different fat fractions in dry-cured ham slices sufficiently simple, accurate and precise. The presented image analysis approach steers towards the development of instruments that can overcome destructive, tedious and time-consuming chemical determinations. As future perspectives, the results of the proposed image analysis methodology will be compared with those of sensory tests in order to develop a fast grading method of dry-cured hams based on fat distribution. Therefore, the system will be able not only to predict the actual fat content but it will also reflect the visual appearance of samples as perceived by consumers.

Keywords : dry-cured ham, edge detection algorithm, fat content, image analysis
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