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Classification of pre-sliced pork and Turkey ham qualities based on image colour and textural features and their relationships with consumer responses

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ABSTRACT

Images of three qualities of pre-sliced pork and Turkey hams were evaluated for colour and textural features to characterize and classify them, and to model the ham appearance grading and preference responses of a group of consumers. A total of 26 colour features and 40 textural features were extracted for analysis. Using Mahalanobis distance and feature inter-correlation analyses, two best colour [mean of S (saturation in HSV colour space), std. deviation of b*, which indicates blue to yellow in L*a*b* colour space] and three textural features [entropy of b*, contrast of H (hue of HSV colour space), entropy of R (red of RGB colour space)] for pork, and three colour (mean of R, mean of H, std. deviation of a*, which indicates green to red in L*a*b* colour space) and two textural features [contrast of B, contrast of L* (luminance or lightness in L*a*b* colour space)] for Turkey hams were selected as features with the highest discriminant power. High classification performances were reached for both types of hams (>99.5% for pork and >90.5% for Turkey) using the best selected features or combinations of them. In spite of the poor/fair agreement among ham consumers as determined by Kappa analysis (Kappa-value < 0.4) for sensory grading (surface colour, colour uniformity, bitonality, texture appearance and acceptability), a dichotomous logistic regression model using the best image features was able to explain the variability of consumers' responses for all sensorial attributes with accuracies higher than 74.1% for pork hams and 83.3% for Turkey hams.

1. Introduction

The term 'ham' implies the thigh and rump of pork, cut from the haunch of a pig or boar, which may be fresh, dry cured (country hams) or wet-cured (city hams) and then boiled or smoked. Hams consist of at least 20.5% protein (not counting fat portions) and without added water (Arboix, 2004). However, the term can be legally applied to products like Turkey hams, if the meat is taken from the breast or leg of this bird. A variety of hams made from countless meat products are now available in the trade which are cured and smoked by different methods (Feiner, 2006). Pre-sliced hams, also known as picnic hams are considered inexpensive substitutes for regular hams, the production and commercialization of thin ham slices made particularly from pork, Turkey and poultry is now going through its most significant increase as demanded by the industry and consumers for catering, delicatessen, and ingredient usage. Accordingly, quality inspection based on the identification of objective methods and quality features of these products becomes increasingly important to the pre-sliced ham product manufacturers (Becker, 2002).

Colour is considered a fundamental physical property of food products, since it has been widely demonstrated that it correlates well with physical, chemical and sensorial indicators of product quality (Mendoza, Dejmek, & Aguilera, 2006; Kaya, Ko, & Gunasekaran, 2008; Quevedo, Aguilera, & Pedreschi, 2009; Fathi, Mohebbi, & Razavi, 2009). Colour is the first sensation that the consumer perceives and is used as an indicator for the acceptance or rejection of a particular food. Colour information also allows the detection of certain anomalies or defects that food items may have (Abdullah, Guan, Lim, & Karim, 2004; Du & Sun, 2004; Hatcher, Symons, & Manivannan, 2004; Kumar & Mittal, 2009; Pedreschi, Aguilera, & Brown, 2000). Consequently, colour plays a major role for the quality assessment in the food industry and food engineering research (Abdullah et al., 2004; Segnini, Dejmek, & Öste, 1999). Particularly, in the pork and bird processing industries, colour represents a critical factor which is commonly used as a quality index of the history of the meat in relation to the sanitary and freshness status of raw carcases, composition, quality of slaughtering and handling process, processing conditions and formulations. It directly affects the price and final quality of processed meat products, like

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