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PORK QUALITY ASSESSMENT: COMPUTER VISION TECHNOLOGY AND PHYSICOCHEMICAL TRAITS

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I. INTRODUCTION

Pork is an important source of animal protein, and the need to enhance meat quality has prompted industry stakeholders to assess how their practices influence product value, as quality defects could jeopardise the sector's competitiveness [1, 2]. A common defect in pork quality is the PSE (Pale, Soft, Exudative) condition, caused by stress and genetic factors, leading to a rapid pH drop shortly after death. As a consequence, protein denaturation increases, primarily of myofibrillar proteins, resulting in heightened exudation and greater light reflectance or scattering [3, 4, 5]. Physicochemical and sensory characteristics of pork have been used to categorize quality as normal or PSE. However, these methods are typically destructive and time-consuming. As a result, there is growing interest in fast, non-destructive techniques such as computer vision [6].

This study aims to develop a model that estimates pork quality using a computer vision system.

II. MATERIALS AND METHODS

The *longissimus thoracis et lumborum* (LTL) muscle on the left side of the carcasses of 21 male pigs, excised at 24h *pm*, was used to assess pork quality. The pH at 24h *pm* was measured directly on the meat. The colour coordinates: L* (lightness), a* (redness), b* (yellowness), C* (chroma), and h (hue angle) were measured after 1h of blooming using a Minolta CR-400 colorimeter. The intensity of the red colour by sensory analysis was evaluated on a scale of 1 to 7. Drip loss was assessed after 3 days of storage at 4°C in trays covered with polythene film. Cooking loss was assessed after 3 days *pm* in samples cooked in polythene bags in a water bath at 80°C until they reached 71°C internally [7]. For shear force determination, samples processed for cooking loss were cut into parallelepipeds with muscle fibres parallel to the length and placed on a Warner-Bratzler rectangular notch probe coupled to a TA.XT plus texturometer with a 30kg load cell, blade velocity of 200mm/min, and trigger force of 5.00g [8].

Samples were photographed using a Sony α58 digital camera (20 MP; 1/8 at F7.1; ISO 100) in a darkroom with four LED bulbs (1710 lm each) and a PET LED light diffuser film. The captured images were analysed using a MATLAB-developed algorithm to calculate the average L^*_{image}, a^*_{image}, and b^*_{image} values in the region of interest. Seventy-five percent of the images were used to build the model in XLSTAT, while the remaining images were used for testing.

III. RESULTS AND DISCUSSION

Samples with both $L^*_{24h} > 55$ [2, 5] and drip loss > 6.5% [4, 9] were classified as PSE, while the rest were considered normal. Table 1 shows the mean, standard deviation and range of pork LTL muscle quality traits after 24 h *pm*.

Table 1. Mean, standard deviation (SD) and range of pork quality traits (n=21).

	Mean	SD	Range
pH	5.49	0.11	5.24 – 5.72
L*	54.89	2.21	50.78 – 59.64
a*	6.10	1.23	4.17 – 8.97
b*	5.99	1.04	4.35 – 7.58
C*	8.57	1.52	6.10 – 11.44
h°	44.61	3.40	38.58 – 51.95
Drip loss (%)[1]	6.66	1.02	5.12 – 8.38
Cooking loss (%)[1]	30.81	3.60	24.87 – 37.92
Shear Force ($N.cm^{-2}$)	44.72	7.76	32.49 – 57.25
Red Colour (sensory analysis)[2]	3.48	0.68	2.00 – 4.00

[1] Expressed as a percentage of mass loss in relation to the initial mass.

[2] The intensity of red colour (24 hours *post-mortem*) varies on a scale of 1 to 7 (1 – pale; 7 – dark).

Principal Component Analysis (PCA) successfully differentiated the colour information of PSE and normal pork obtained from computer vision-based image analysis, with a 90% success rate (Figure 1). PC1 and PC2, which explain 95.47% of the data variability, show that PSE pork samples form a distinct cluster at the top, whereas normal pork samples are positioned at the bottom. Test data from PSE pork samples (TP4 and TP6) clustered with PSE pork, while normal test pork samples (TP1, TP2, TP3, and TP5) clustered with the normal ones.

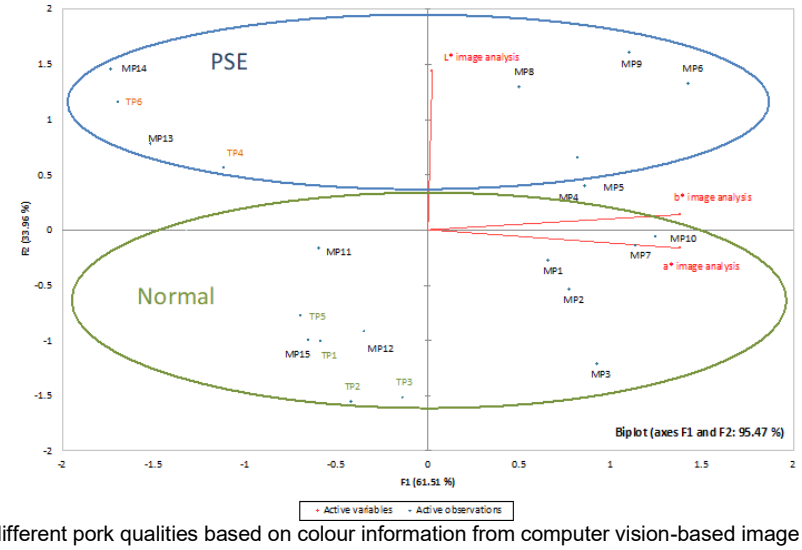


Figure 1. Classification of different pork qualities based on colour information from computer vision-based image analysis. MP: Model pork data; TP: Test pork data.

IV. CONCLUSION

Computer vision-based image analysis successfully estimated the quality of PSE and normal pork based on colour information. This technique is promising compared to conventional methods due to being non-destructive, fast, and easily adaptable to slaughterhouses.

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