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UNDERSTANDING THE FACTORS AFFECTING PORK BELLY SHELF LIFE AT RETAIL

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I. INTRODUCTION

Pork belly is a highly valued meat with a rich flavour and texture, mainly due to its high fat content. In response to consumer demand for leaner products, selection has shifted towards bellies with reduced fat content, resulting in bellies that are more prone to oxidation [1]. Understanding the factors that influence the shelf life of pork belly at retail level is essential for providing meat producers and processors with guidelines that ensure shelf life preservation while meeting consumer preferences. Previous work by the authors has shown that the effectiveness of packaging solutions for fresh pork belly varies with the fat content of the product [2]. The findings highlight the need to tailor packaging strategies to specific product characteristics to optimise shelf life and minimize the environmental impact. Leaner bellies, such as those from Pietrain pigs, are particularly vulnerable to oxidation due to their higher levels of unsaturated fatty acids. For such products, packaging in high-oxygen modified atmosphere (MAP) may significantly shorten shelf life [3]. The aim of the present study was to investigate the impact of different lighting conditions on the shelf life of pork bellies with varying fat content packed in MAP with high oxygen concentration.

II. MATERIALS AND METHODS

Deboned pork bellies (n = 9) were selected from a local cutting plant to obtain a range of bellies with different fat content: low-fat (LF) bellies from Pietrain crossbred pigs with low fat content (22.6±5.6 % fat), medium-fat bellies (MF) from Pietrain crossbred pigs with high fat content (37.8±3.6 % fat), and high-fat bellies (HF) from Duroc pigs (56.8±4.3 % fat). Bellies were sliced, packed in MAP (30:40:30%, O_2:CO_2:N_2), and stored at 4.8± 0.7°C under 12-h lightness/ 12-h darkness cycles using 3 lighting conditions: LUX1, Philips T8 meat LED tube, 1200 lux; and LUX2, LUX3 with PROMOLUX T5 meat LED tube, at 1200 and 2000 lx, respectively. Sampling was performed at 0, 6, 10, 15 and 20 days. Purge, pH, colour coordinates of the lean, oxidation (TBARS), and total viable counts (TVC), were measured. Sensory evaluation was carried out by seven trained assessors using aroma loss, rancid odour, and lean, fat, and skin colour descriptors, developed in prior sessions. A non-structured 1-5 scale was used, with scores ≥3 indicating unacceptability. Data were analysed using a general linear model in JMP 16.0, with belly type, lighting, time, and their interactions as fixed effects. Differences were evaluated using Tukey's test ($P < 0.05$). Shelf life was estimated using JMP's inverse prediction function, based on fitted models for each sensory attribute, following the approach of Marcos et al. [2]. The most limiting parameter was used to define shelf life. A principal component analysis (PCA) was carried out to investigate the relationships between variables and type of samples.

III. RESULTS AND DISCUSSION

Figure 1 shows the results of the PCA, where PC1 and PC2 together explained 82.5% of the total variability. PC1 reflects the progression of shelf life, with variable a^*_{lean} strongly associated with the positive end, indicating freshness, while parameters related to quality deterioration loaded negatively.

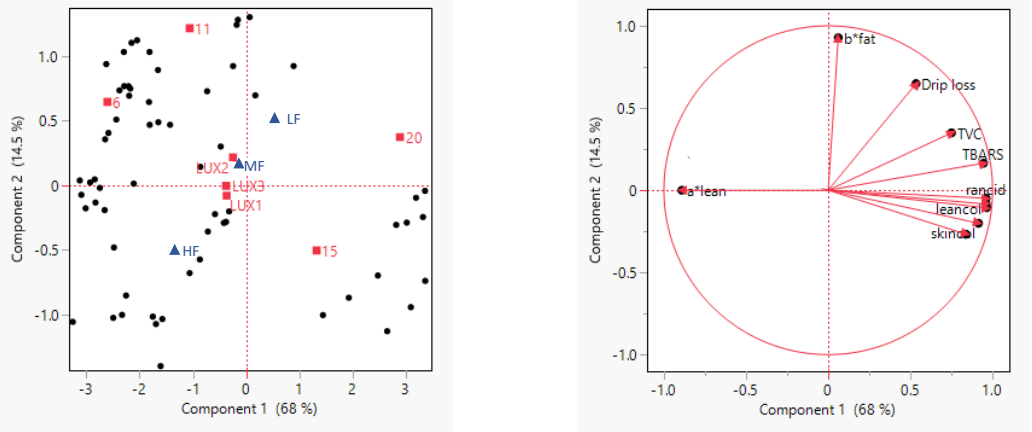


Figure 1. PCA score and loading plot of pork bellies

PC2 differentiated between belly fat types, with LF and HF samples on opposite sides. Lighting conditions clustered near the origin in the score plot, suggesting minimal impact on product quality relative to time and fat content, an observation supported by the statistical analysis (data not shown). At the end of storage, HF bellies exhibited significantly lower TBARS values (0.51 ± 0.20) and higher lean redness (a^*_{lean} = 9.61 ± 1.59) compared to LF and MF samples, which showed TBARS of 1.00 ± 0.61 and 1.88 ± 0.54, and a^*_{lean} of 2.86 ± 1.51 and 5.81 ± 1.31, respectively.

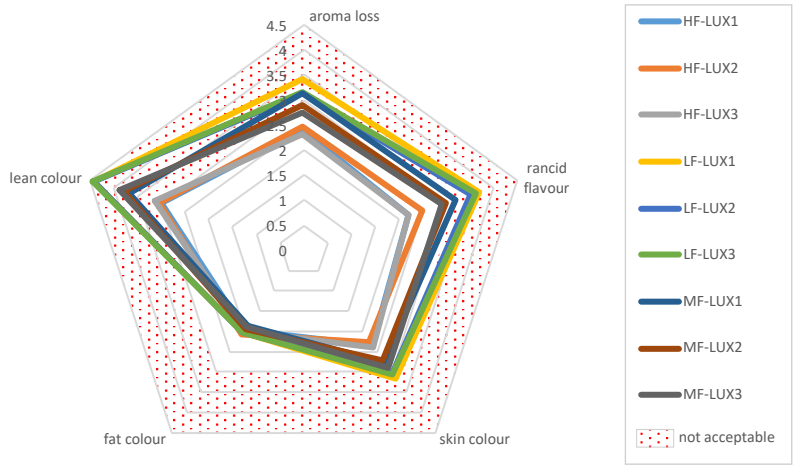


Figure 2. Spider web graph of sensory attributes of pork belly at the end of refrigerated storage (day 20).

Figure 2 illustrates the sensory evaluation of pork belly slices after 20 days of refrigerated storage. Among all descriptors, lean colour was the most limiting sensory attribute after 20 days of storage, in line with prior studies identifying it as a key shelf-life indicator [2,3]. Figure 2 shows that HF samples consistently outperformed MF and LF in aroma, rancidity, and colour stability, highlighting the higher oxidative stability in bellies with higher fat content, and higher content of unsaturated fatty acids. This supports earlier findings on the importance of belly type in determining packaging requirements in terms of product protection [2]. Table 1 confirms that HF bellies consistently showed the longest predicted shelf life across all sensory attributes.

Table 1 – Shelf-life prediction of sliced belly for low fat (LF), medium fat (MF), and high fat (HF) bellies

Belly type	aroma loss		rancid odour		fat colour		lean colour	
	predicted[1]	lower 95%[2]	predicted[1]	lower 95%[2]	predicted[1]	lower 95%[2]	predicted[1]	lower 95%[2]
LF	17.00	16.21	14.81	14.14	31.80	29.65	12.99	**12.29**
MF	19.53	18.00	18.56	16.74	36.17	32.38	14.37	**12.54**
HF	25.58	22.47	26.68	22.20	37.23	32.45	20.47	**17.71**

[1] Predicted: estimation of the time (days) at which the bellies reached the acceptability threshold set at score 3,[2] Lower 95% confidence limit (days). Values in bold indicate the worst estimated shelf life of each belly type-illumination combinations.

IV. CONCLUSION

The study confirmed the role of lean colour as an early quality indicator for retail pork belly. HF bellies showed greater colour and fat stability, resulting in a longer shelf life. Lighting type and intensity had no significant effect on shelf life, suggesting it is not a critical factor for this product under the tested conditions. These findings highlight the importance of considering fat content when assessing pork belly shelf life and quality.

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REFERENCES

1. Soladoye, P. O., Shand, P. J., Aalhus, J. L., Gariépy, C., and Juárez, M. (2015). Review: Pork belly quality, bacon properties and recent consumer trends. Canadian Journal of Animal Science. 95(3): 325-340.
2. Marcos, B., Quinteiro, P., Albano-Gaglio, M., Muñoz, I., Claret, A., Guerrero, L., . . . Font-i-Furnols, M. (2024). Tailor-made packaging strategies of fresh pork belly with different fat content: . Meat Science, 217, 109627.
3. Albano-Gaglio, M., Esquerre, C. A., O'Donnell, C. P., Muñoz, I., ElMasry, G., Font-i-Furnols, M., . . . Marcos, B. (2025). Calibration of visible and near-infrared spectral imaging technology to predict the quality evolution of retail fresh pork bellies with different fat content. Food Research International, 199, 115350.