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IMPACT OF FRESH VS. THAWED LIVER ON THE QUALITY OF DANISH LIVER PÂTÉ

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I. INTRODUCTION

Freezing and storing raw materials like pork liver – a key ingredient in Danish pâté – offers practical and economic benefits, including supply chain flexibility, reduced waste and resource efficiency. However, freezing can compromise quality due to ice crystal formation, which ruptures cells, leading to the loss of intracellular components and protein denaturation due to localized increases in solute concentrations [1]. These changes may reduce water-holding capacity and pâté cohesiveness. Additionally, frozen storage can accelerate lipid and protein oxidation, reducing both quality and visual appeal [2].

Despite these challenges, freezing remains an essential tool for maintaining supply chain stability and managing market demand fluctuations. This study investigated whether pâté quality was affected when using frozen/thawed pork liver compared to fresh liver by assessing cooking and cooling losses, colour stability and firmness (shear force).

II. MATERIALS AND METHODS

Livers were collected at a commercial slaughterhouse. Six fresh livers were minced the day after slaughter, while six frozen livers, frozen at -20°C three weeks earlier, were thawed at 3°C before processing. The thawing juice was included in the pâté preparation. Each liver (approx. 1600 g) was minced individually, and 625 g was used to prepare 2000 g of pâté using a standard recipe (31.29% liver, 28.27% lard, 31.29% soup, 9.15% spices). Five pâtés (380 g each) were made per liver, resulting in 30 pâtés per treatment (fresh and frozen/thawed).

The pâté stuffing was mixed (Vorwerk Thermomix® TM6-1), moulded and baked (Electrolux Air-O-Stream) at 200°C until the core temperature reached 80°C. The cooking loss was calculated as the difference between raw and cooked weights, measured immediately after baking. The cooling loss was based on the difference between cooked and cooled weights, which were measured after 24 hours at 3°C.

Colour stability and firmness of the cooked and cooled pâtés (stored at 4°C) were tested on days 1, 8 and 22. Colour was measured on the inner cutting surface at 519 nm, 572 nm and 625 nm – wavelengths relevant for myoglobin reflectance [3] – using VideometerLab. Shear force (firmness) was tested with a fixed-diameter drill (2.1 mm) and a texture analyser (TA.XTPlus 100). Measurements were performed in duplicate.

Statistical analysis was performed in RStudio (version 2024.12.1+563). Cooking and cooling losses were analysed using a nested ANOVA with a linear mixed-effects model (nlme package):

$$Y_{ij} = \mu + \alpha_i + b_j + E_{ij}, \;\; b_j \sim N(0, \sigma_b^2), \;\; E_{ij} \sim N(0, \sigma_E^2)$$

For colour stability and shear force, the model included time and the interaction between liver type and time:

$$Y_{ijk} = \mu + \alpha_i + \gamma_k + (\alpha\gamma)_{ik} + b_j + E_{ijk}, \;\; b_j \sim N(0, \sigma_b^2), \;\; E_{ijk} \sim N(0, \sigma_E^2)$$

In both models, Y represents the response variable, μ is the overall mean, α is the fixed effect of liver type (fresh, frozen/thawed), b is the random effect of the individual liver, γ is the fixed effect of time, $\alpha\gamma$ represents the interaction between liver type and time, and E is the residual error.

Post hoc pairwise comparison of means were conducted using the Tukey method to identify significant differences between pâtés from fresh vs. frozen/thawed liver for cooking and cooling loss data. For colour stability and shear force data, pairwise comparison of estimated marginal means were performed to evaluate the interaction between time and liver type, highlighting significant differences.

III. RESULTS AND DISCUSSION

Table 1 – Cooking and cooling losses and firmness results (α = 0.05).

Analysis		Fresh liver	Frozen/thawed liver	p-value	n
Cooking loss (%)		5.5 ± 1.4	5.9 ± 1.0	0.543	30
Cooling loss (%)		5.9 ± 1.2	6.3 ± 0.9	0.518	30
Firmness (N)	Day 1	4.2 ± 1.1	3.8 ± 0.9	0.589	12
	Day 8	4.8 ± 1.2	4.2 ± 1.0	0.381	12
	Day 22	5.1 ± 1.2	4.8 ± 1.3	0.659	12

Cooking and cooling losses

Pâtés prepared from frozen/thawed liver did not exhibit significantly higher cooking or cooling losses compared to those made from fresh liver (Table 1). This indicates that freezing and thawing did not impair the retainment of moisture in the pâtés.

Colour analysis

Pâtés made from fresh liver maintained stable reflectance at 519 nm and 572 nm over time, whereas those made from frozen/thawed liver showed a slight decrease in reflectance at these wavelengths. These trends are depicted in Figure 1A, where the changes in reflectance at 519 nm and 572 nm for frozen/thawed liver pâtés are minimal and not statistically significant. At the same time, pâtés from fresh liver exhibited a slight increase in reflectance at 625 nm, while those from frozen/thawed liver remained more stable (Figure 1A). No significant differences were observed between the two groups – fresh vs. frozen/thawed – throughout the study, and all pâtés exhibited acceptable colour stability during the storage period.

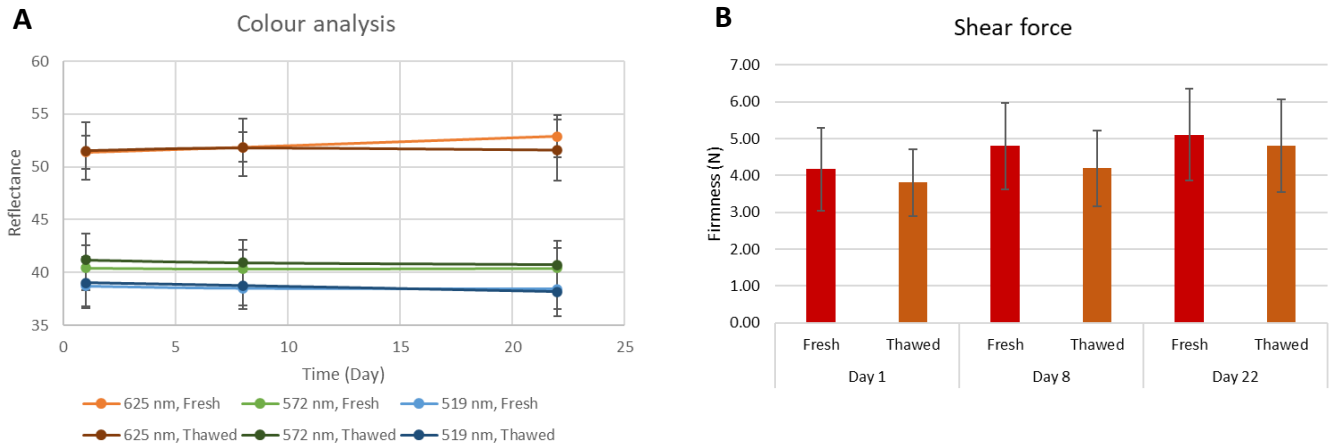


Figure 1. Results from the colour analyses are presented in Figure A, and shear force results are presented in Figure B. For both figures, the average is based on 12 patés measured in duplicate, the error bars indicate the standard deviation across all 12 measurements. "Fresh" refers to pâtés from six fresh livers, and "Thawed" to pâtés from six frozen/thawed livers.

Firmness (shear force analysis)

Firmness increased (tendency) for all pâtés over the 22-day storage period (Figure 1B). However, the differences in firmness between pâtés made from fresh liver and those made from frozen/thawed liver were not statistically significant as shown in Table 1.

IV. CONCLUSION

The process of freezing and thawing the livers had no significant impact on the cooking and cooling losses, colour stability or firmness of Danish liver pâté over the 22-day study period when compared to using fresh liver. These results suggest that frozen/thawed liver is a viable alternative to fresh liver for pâté production, as it maintains comparable firmness, colour and moisture retention. However, this study did not evaluate the effects of long-term frozen storage of livers, which could be a valuable subject for future research.

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