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# SENSORY IMPLICATIONS OF DEEP CHILLING OF HAM

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## I. INTRODUCTION

Cured, whole ham is the most popular item in the Swedish Christmas dinner [1]. The quality and pricing of ham, that can vary substantially, are important factors for consumers [2]. Currently, the production of Swedish ham for the next year's Christmas starts in March, making the supply chain heavily dependent on cold storage. Industrial efficiency improvements are therefore sought after. Extended storage time (3 to 6 months) at near-frozen conditions (i.e. deep-chilling), may be a method for meat processors to ensure that a sufficient amount of hams are available throughout the year and during peak periods, while preserving product safety and quality [3].

However, the effect of deep-chilling on sensory characteristics of cured, cooked ham is not well investigated. In the present study, the sensory quality of freshly produced cured and cooked ham was compared to cured and cooked ham stored at -1.4°C for 30 or 52 weeks and at +2°C for 30 weeks.

## II. MATERIALS AND METHODS

Cured, vacuum-packed and cooked hams were subjected to three different storage methods, at -1.4°C for 30 or 52 weeks and at +2°C for 30 weeks. A freshly produced ham, processed identically, was used as a reference. For evaluation of off-odours associated with storage, one ham per storage method was divided into 10-gram pieces, vacuum packed individually and stored accordingly. Microbiological safety was verified through routine analyses at the processing plant. After storage, the hams were transported to the sensory laboratory at Kristianstad University.

The hams were evaluated using descriptive sensory analysis (DA) while the samples prepared for analysis of off-odours were evaluated using the Rate-All-That-Apply (RATA) method directly upon opening. The samples for odour analysis were masked with aluminum foil (Figure 1). The analyses were performed using a selected and trained panel consisting of six panellists. The samples were served at room temperature, in triplicates, in coded containers and in a random order in a sensory laboratory. Panellists were provided crackers and water to clean the palate between samples. The results were documented and reported using the EyeQuestion software (version 5.12.12). Discrimination between samples was evaluated using ANOVA with a post hoc test according to Tukey. The ethical conduct was given approval through an Advisory Opinion, Dnr: 2024-2.3.4-853 from Kristianstad University Ethics Council.

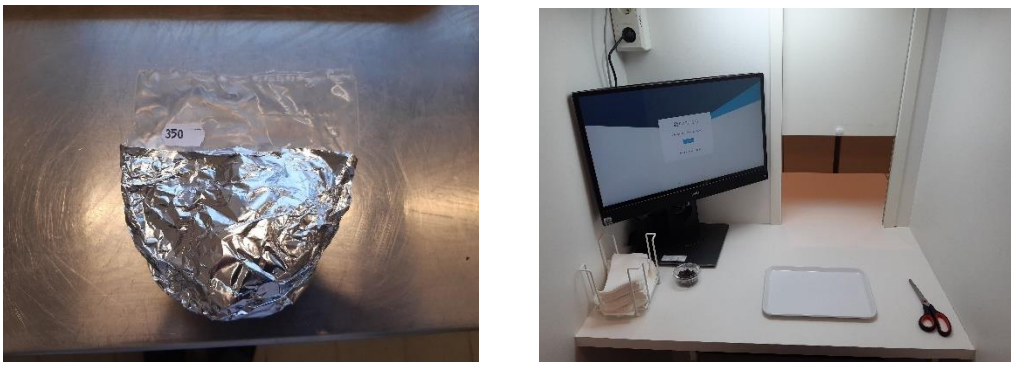



Figure 1. The samples prepared for analysis of off-odours were masked with aluminum foil and cut open by the panelists in the booth prior to evaluation using the RATA method.

## III. RESULTS AND DISCUSSION

The analytical panel found nineteen attributes to describe the odour, appearance, taste, flavour and texture of the hams. Overall, the 52-week deep chill storage only affected the sensory perception in that these samples were evaluated as having a more intense smoky odour and flavour ($p < 0.05$). Interestingly, none of the odours or flavours that could presumably be associated with storage, like stale/barny or a persistent aftertaste, were perceived as more intense in the ham stored for one year at -1,4°C. The freshly produced ham was perceived as having a more nutty odour ($p < 0,05$) as well as a more intense odour and flavour of cooked pig meat ($p < 0.05$).

In the samples that were evaluated for off-odours, 12 attributes to describe the odour were identified: Iron, smokiness, cooked pork, nuttiness, instant mashed potatoes, dry pet feed, rancidity, soured milk, cooked yellow peas, canned ham, boar taint (urine), stale (barn-like/musty). The panellists were unable to detect any differences in odour between the storage treatments other than that the sample stored for one year at -1.4°C was perceived as having a more intense odour of instant mashed potatoes than the sample stored at -1.4°C for 30 weeks. The samples stored for 30 weeks, irrespective of storage temperature, covaried in the bi-plot (Figure 2). Although the evaluation of off-odours introduced a risk of contamination, no such effect was observed. Instead, the results indicate that no apparent off-odours arose during deep-chilling of cured, cooked ham for one year.

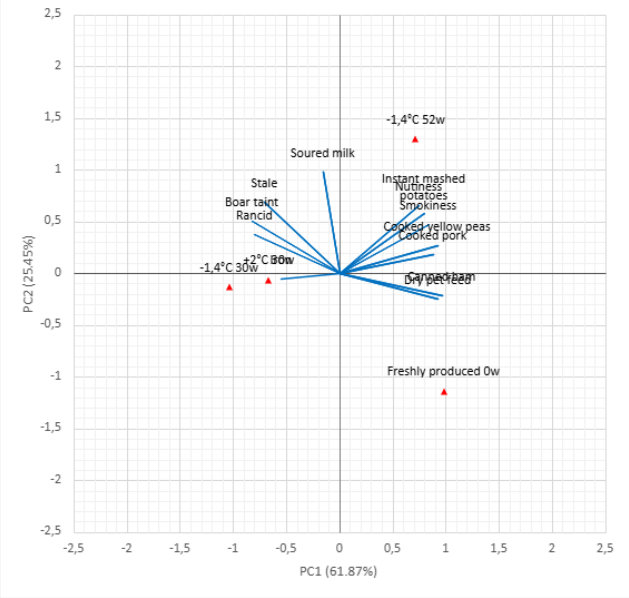



Figure 2. Biplot of the odour evaluation of four samples of cured, cooked ham.

## IV. CONCLUSION

This study demonstrates that deep-chilling cured, cooked ham for up to 52 weeks preserves sensory quality at a commercially acceptable level. No negative effects on odour, flavour, or texture were observed, suggesting that deep-chilling, from a sensory perspective, is a viable method for long-term storage. To confirm feasibility, further comparative studies are needed to fully evaluate the chemical, sensory, and microbial impacts of deep-chilling for prolonged periods relative to conventional storage times.

## ACKNOWLEDGEMENTS

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## REFERENCES

1. The Swedish Food Federation (2024). https://www.livsmedelsforetagen.se/app/uploads/2024/11/livsmedelsforetagens-stora-julmatsundersokning-2024.pdf
2. de Araújo, P. D., Araújo, W. M. C., Patarata, L., & Fraqueza, M. J. (2022). Understanding the main factors that influence consumer quality perception and attitude towards meat and processed meat products. *Meat Science*, *193*, 108952. https://doi.org/10.1016/j.meatsci.2022.108952
3. Luchansky, J. B., Campano, S. G., Shoyer, B. A., & Porto-Fett, A. C. (2016). Viability of Listeria monocytogenes on boneless, water-added hams, commercially prepared with and without food-grade chemicals, during Extended Storage at 4 and/or−2.2 C. Journal of Food Protection, 79(4), 613-619. https://doi.org/10.4315/0362-028X.JFP-15-431