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SYNCROTRON UV FLUORESCENCE EMISSION FROM MUSCLE CELLS VARIES WITH MEAT SALTING

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I. INTRODUCTION

Sodium chloride is used in meat processing as a flavour enhancer, preservative, and texture-control agent. In the French processed meat "petit salé," the salt content ranges from 1.1% to 1.9%. The addition of salt increases the ionic strength in muscle tissues, leading to protein denaturation, the extent of which varies depending on the fibre type [1]. On the other hand, the autofluorescence of aromatic amino acids can be altered by protein conformational changes and by the formation of new compounds involving proteins and amino acids [2]. The objective of this study was to characterize the effect of salting on different types of pork muscle fibres (contractile and metabolic) through their autofluorescence emission. The study aimed to develop a fast, non-destructive method to optimize salting processes and reduce variability related to meat quality.

II. MATERIALS AND METHODS

This study was conducted on the *teres major* (TM) muscle of four 6-month-old female pigs (Pietrain x [Large White x Landrace]) with an average carcass weight of 91.9 ± 7.29 kg. The pigs were slaughtered in a certified abattoir in compliance with European animal welfare regulations. Muscle samples (150 g) were collected 24 hours postmortem and subjected to three salting treatments: 0.9% NaCl (control), 1.3%, and 1.9% NaCl. The samples were vacuum-sealed, tumbled for 16 hours, and stored at 4 °C for 48 hours to promote salt diffusion.
Using Synchrotron deep UV fluorescence microspectroscopy on the DISCO beamline at the synchrotron SOLEIL (Gif sur Yvette, France), emission spectra (Ex. 275 nm) were collected from label free muscle histological sections before and after salting. The analysis, targeted muscle fibres previously identified by histochemistry based on their sub-type (I, IIA, IIB-IIX).
The spectra were processed using homemade MATLAB programs and analysed through PCA and ANOVA. These methods enabled the evaluation of the effects of salting treatments, fibre types, and inter-individual variations on the fluorescence spectra.

III. RESULTS AND DISCUSSION

The high variability between individuals, observed in both control and salt-treated samples, led us to analyse the data for each animal individually. In PCA scatter plots (Figure 1), autofluorescence spectra differentiate between NaCl concentrations, while fibre types remain mixed except in the control samples of An2 (Figure 1, 2nd column) which exhibited a high ultimate pH (6.16 compared to an average of 5.68 for the other pigs). In a previous study using the same approach [3], fluorescence emission from rat muscle fibre types with a pH above 6.0 were discriminated suggesting an effect of muscle pH on fluorophore efficiency. Across all four animals, the PCA plots clearly separate salt levels, though this distinction is less pronounced for An3. For this animal (Figure 1, 3rd column), the 1.3% and 1.9% NaCl samples are well separated, but control samples (C), particularly those with type IIA fibres, show significant dispersion and overlap with other classes. This variability in IIA fibre autofluorescence might result from heterogeneity in localized salt content or genetic factors. As observed in a previous study [4], no simple relationship links fluorescence variations to salt levels.

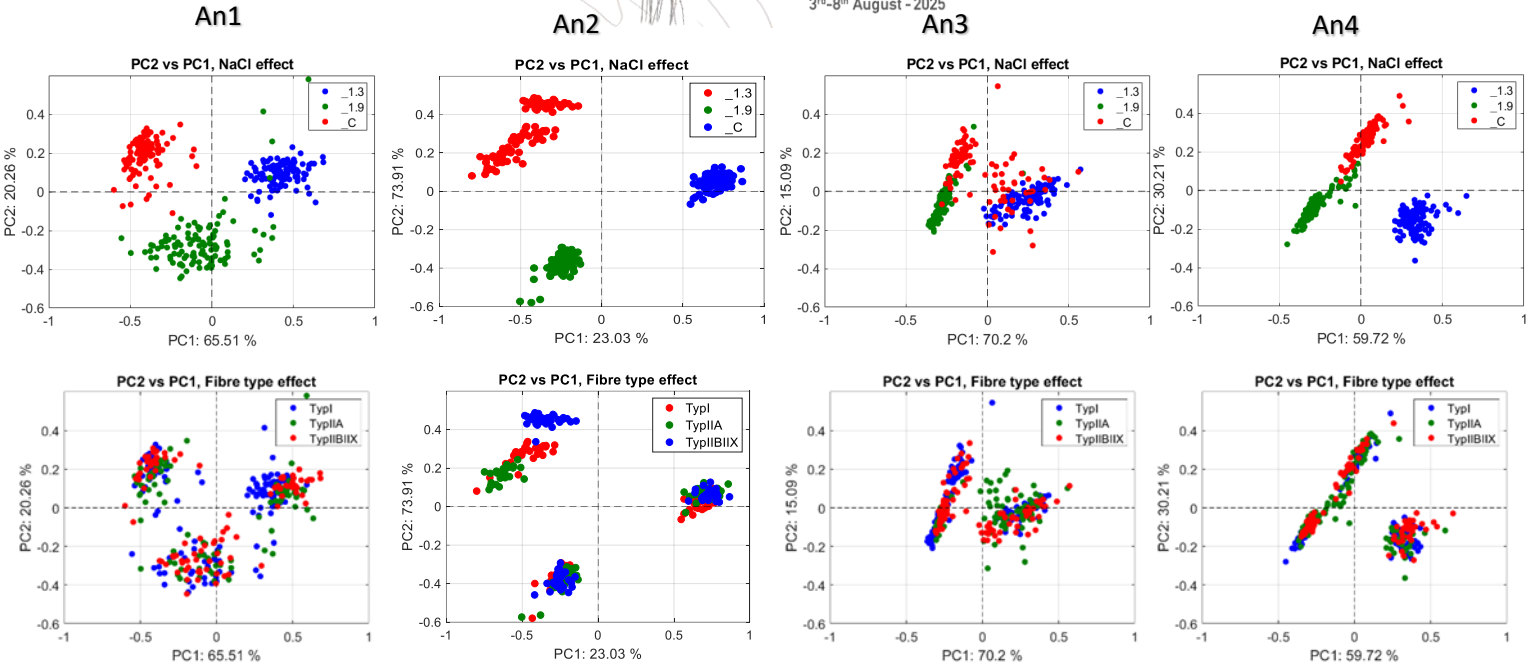


Figure 1. Results from salt treated samples of individual animals. PCA scatter plots, according to the NaCl and fibre type factors, using data of 3 NaCl concentrations and the 3 muscle fibre types for each of the 4 animals.

IV. CONCLUSION

This study analysed the effect of salting on the autofluorescence of identified muscle fibres under Synchrotron deep UV excitation. Excitation at 275 nm generated intense tryptophan fluorescence (maximum at 340 nm) and an emission around 395 nm, attributed to dityrosine. Unlike findings in rat muscle study, fluorescence emission did not vary with fibre type, except in one animal with a high ultimate pH. Spectrofluorometric analysis revealed significant interindividual variability, preventing salt level discrimination at the group level. However, PCAs revealed a clear discrimination of fluorescence response based on salt content. These results suggest that in the future, fluorescence spectroscopy could be used in the meat industry to assess salt content in processed meat. Further research is needed to better understand the influence of physicochemical characteristics, such as ultimate pH, on muscle fibre autofluorescence.

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REFERENCES

1. Xiong, Y. L., Lou, X., Harmon, R. J., Wang, C., & Moody, W. G. (2000). Salt- and pyrophosphate-induced structural changes in myofibrils from chicken red and white muscles. Journal of the Science of Food and Agriculture, 80(8), 1176–1182. https://doi.org/10.1002/1097-0010(200006)80:8<1176:AID-JSFA615>3.0.CO;2-M
2. Lakowicz, J. R. (2006). Principles of Fluorescence Spectroscopy (3rd Edition). Springer Science & Business Media.
3. Chagnot, C., Venien, A., Peyrin, F., Jamme, F., Refregiers, M., Desvaux, M., & Astruc, T. (2015). Deep UV excited muscle cell autofluorescence varies with the fibre type. Analyst, 140(12), 4189–4196. https://doi.org/10.1039/c5an00172b
4. Abou El Karam, S., Ferrand, M., El Jabri, M., Vautier, A., Carlier, M., Germond, A., & Astruc, T. (2023). Influence of sodium chloride on muscle UV autofluorescence characteristics. Food Chemistry, 410, 135352. https://doi.org/10.1016/j.foodchem.2022.135352