PROGRESS TOWARDS INLINE SPECTRAL SENSING OF LACTATE IN PIG BLOOD AT EXSANGUINATION

Theo Verkleij[1], Puneet Mishra[1,2*], Esra Kurt[3], Rick van de Ven[3], Sjaak Wisse[3] and Ronald Klont[3]

[1]Food and Biobased Research, Wageningen University and Research, The Netherlands

[2]Agro-Food Robotics, Wageningen University and Research, The Netherlands

[3]Vion Food Group, The Netherlands

*Corresponding author email: puneet.mishra@wur.nl

I. INTRODUCTION

When pigs are stressed or handled improperly at the lead-in to the stunning process their muscles may use more energy than usual, leading to an increase in blood lactate levels. This increase in blood lactate levels may coincide with an increased post-mortem glycolysis, leading to a faster decrease in muscle tissue pH. This increase in post-mortem pH-fall can cause meat to become tougher and less palatable (Xing *et al.*, 2019). Therefore, it is important to minimize stress during preslaughter handling and transportation of animals to slaughterhouses in order to maintain good meat quality (Hambrecht *et al.*, 2004). Additionally, blood lactate levels can be used as an indicator of animal welfare.
Optical spectroscopy is a technique that can be used to measure lactate in animal blood. It involves the use of light to analyse the properties of a sample, including its chemical composition. Commonly used spectral techniques for lactate assessment in blood are near infrared (NIR) (Baishya *et al.*, 2021), and Raman spectroscopy (Olaetxea *et al.*, 2020). Spectroscopic techniques offer several advantages over other methods for measuring lactate in animal blood, including non-invasiveness and the ability to analyse multiple samples simultaneously inline at exsanguination. The aim of the present study was to explore different optical spectroscopy techniques to predict the blood lactate content in pig blood at exsanguination.

II. MATERIALS AND METHODS

The study involves three different trials carried out at different slaughterhouses of Vion Food in, The Netherlands. The first trial was from year 2020, where blood samples immediately after stunning and sticking were measured with a hand-held lactate analyser (Lactate Scout 4, EFK Diagnostics, United Kingdom) and near-infrared (NIR) spectrometer (Labspec, ASD, Malvern Panalytical, USA). The NIR spectrometer had an inbuilt halogen light source for illuminating the blood samples. The NIR measurement was carried out in plastic cups filled with fresh blood and the NIR reflection probe was placed with ~ 2 cm of distance between probe head and blood. Hand-held lactate measurements were performed before spectral measurements. The spectral measurements were performed in reflectance mode as that was the easiest mode of measurements available at the slaughterhouse. During the second trail in 2022, the blood samples were measured with the lactate analyser and a dip probe Raman spectrometer (Wasatch, Photonics, USA). The Raman spectrometer used a laser source of 785 nm to excite the samples. The fresh blood samples were presented in plastic cups where the dip probe was immersed in for measuring lactate. After every scan, the dip probe was cleaned with paper to remove remaining of blood from earlier samples. The integration time was 5 seconds. To find the relation between spectral techniques and lactate values, partial least-squares (PLS) regression was performed. PLS was used as the signals were multivariate. To optimise the number of factors for PLS, leave-one-sample-out (LOO) cross-validation analysis was performed.

III. RESULTS AND DISCUSSION

The blood lactate ranges from the two trails had a mean±standard deviation range of 10±3.45 mMol/L, where for NIR modelling, the lactate range was 11.32±3.24 mMol/L (80 blood samples), and for Raman data modelling, the lactate range was 9.92±3.58 mMol/L (57 blood samples). For both the NIR and

Raman, the lactate range was similar. The PLS regression cross-validation analysis results are shown in Figure. 1. As can be noted, both techniques carried variation related to lactate, but Raman carried higher variation than the NIR. A reason for better explain of lactate variation by Raman could be high sensitivity towards analytes, while NIR signals are usually attenuated by water.

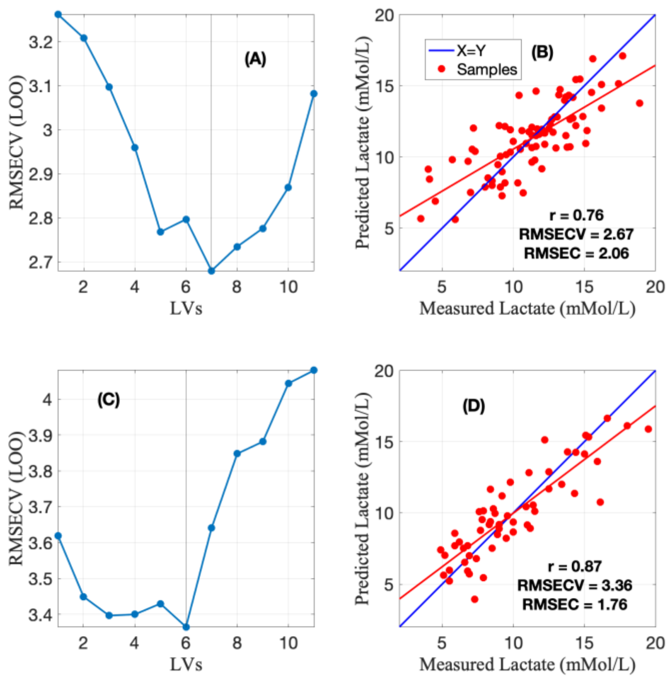

Figure 1. (A) PLS cross-validation for NIR, (B) prediction plot for NIR, (C) PLS cross-validation for Raman, and (D) prediction plot for Raman.

IV. CONCLUSION

The study aimed to explore optical spectroscopy for predicting lactate levels in pig blood during after stunning at exsanguination. The results suggests that both techniques, NIR and Raman, carry variation related to lactate but Raman spectroscopy appears to be more sensitive to predict lactate.

ACKNOWLEDGEMENTS

Pork Quality and Safety Assessment Tools (PorQSAT) LWV19176.

REFERENCES

1. Xing, T., Gao, F., Tume, R. K., Zhou, G., & Xu, X. (2019). Stress effects on meat quality: A mechanistic perspective. Comprehensive Reviews in Food Science and Food Safety, 18: 380-401.
2. Hambrecht, E., Eissen, J. J., Nooijen, R. I. J., Ducro, B. J., Smits, C. H. M., Den Hartog, L. A., & Verstegen, M. W. A. (2004). Preslaughter stress and muscle energy largely determine pork quality at two commercial processing plants. Journal of Animal Science, 82: 1401-1409.
3. Baishya, N., Mamouei, M., Budidha, K., Qassem, M., Vadgama, P., & Kyriacou, P. A. (2021). In-vivo quantification of lactate using Near Infrared reflectance spectroscopy. Proceedings 43rd International Congress of the IEEE Engineering in Medicine & Biology Society (pp. 7024-7027). IEEE.
4. Olaetxea, I., Valero, A., Lopez, E., Lafuente, H., Izeta, A., Jaunarena, I., & Seifert, A. (2020). Machine learning-assisted Raman spectroscopy for pH and lactate sensing in body fluids. Analytical Chemistry, 92: 13888-13895.