WATER DYNAMIC OF AGED BEEF INVESTIGATED TROUGH TD-NMR AND MULTIVARIATE APPROACHES

Nara R. B. Cônsolo[1*], Ana Paula M. de Paula[2], Beatriz M. Foz[1], Luiz A. Colnago[3], Tiago B. Moraes[4], Renata T. Nassu[5], Poliana M. dos Santos[6], Sérgio Bertelli Pflanzer[2]

[1]Department of Animal Science, University of São Paulo, Brazil
[2]School of Food Engineer, UNICAMP, Brazil
[3]Embrapa Instrumentação, Brazil
[4]Department of Biosystems Engineering, University of São Paulo, Brazil
[5]Embrapa Pecuária Sudeste, Brazil
[6]Federal University of Technology – Parana, Brazil
*Corresponding author email: nara.consolo@usp.br

I. INTRODUCTION

Aging process is an important technology used to improve meat quality and eating experience, but different types of aging produce differences on meat organoleptic traits. The dry-aged meat is considered a flavourful product compared to the wet-aged ones [1], however, due the higher amount of shrink and trim losses, some alternatives should be studied, in order to produce meat with flavour near to the dry-aged, but with higher yields. In that way, the use of moisture absorber with or without mechanical tenderization, could remove part of the intramuscular moisture and improve the meat flavour, by flavour concentration. Therefore, the aim of this study was to evaluate the water drying dynamics of meat aged with different methods using TD-NMR relaxometry and multivariate statistical approaches.

II. MATERIALS AND METHODS

A total of 24 bone-in loins from Nellore cattle were assessed in four treatments: Wet) meat aged with vacuum package; Dry) meat aged unpackaged; Abs) meat aged into a vacuum package with moisture absorber (M6175S, McAirlaid's, Germany); and AbsTend) mechanical tenderized meat aged into a vacuum packed with moisture absorber. After 28 days aging, samples were analyse through TD-NMR, using a SLK-IF-1399 (0.23 T) spectrometer with a 10 cm probe. The transverse (T_2) and Longitudinal (T_1) relaxation times were measure using the Carr-Purcell-Meiboom-Gill (CPMG) [2] and inversion-recovery (IR) [4] pulse sequences, respectively. A total of 48 steak samples were used: 24 from to the inner part (INT), consisting to the deepest portion of the steak; and 24 from the meat surface (EXT) consisting of the 3 mm of the surface of each steak. Multivariate analyses were evaluated in MATLAB 2021b and PLS_Toolbox v.9.1 (Eigenvector Research Inc., Wenatchee, WA, USA).

III. RESULTS AND DISCUSSION

Analysing the PCA of the CPMG (T_2) signals of meat inner part (Fig. 1 A), it is possible to suggest some differentiation among the aging techniques. However, an expressive differentiation among treatments was found for CPMG (T_2) signals of meat surface (Fig. 1 B), in which Dry and Wet samples presented a cluster far from each other and from Abs and AbsTen. Nonetheless, an overlapping was observed between the Abs and AbsTen suggesting similarities between them. On regard to the IR (T_1) signals, there was no clear separation among groups for the inner part of the meat (Fig. 1 C); however, when the meat surface (Fig. 1 D) was analysed, the Dry samples segregate from all the others, but an overlapping was found among Wet, Abs and AbsTend groups, suggesting similarities between them. The PCA biplot (Fig. 2) contain the information of the samples and meat physicochemical variables, showing the similar clusters than those obtained with TD-NMR.

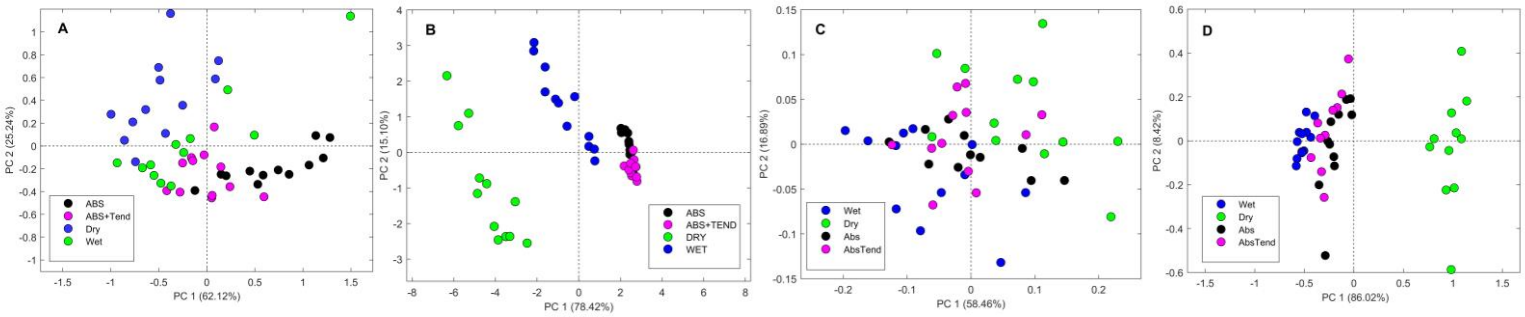

Figure 1. PCA scores plots obtained with the CPMG decays of meat inner part (A) and surface (B) and IR decays of meat inner part (C) and surface (D)

The most important variable for separation of dry-aged meat samples from the others are the meat initial weight (IW) and the meat initial weight –final weight (IW-FW), which are at least two time higher than those obtained for Abs, AbsTend and Wet samples. Such differences are correlated with the higher dehydration process on Dry-aged meat, decreasing the FW when compared with the other treatments.

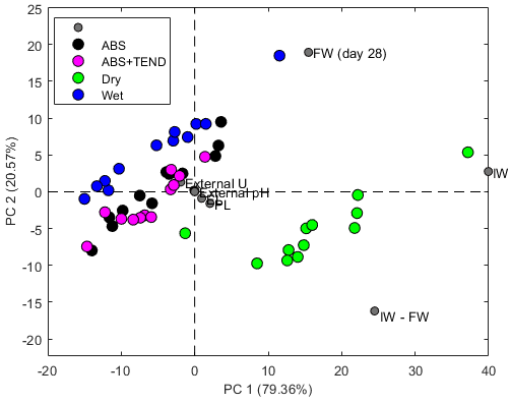

Figure 2. PCA biplot obtained with meat chemical-physical analysis.

IV. CONCLUSION

CPMG (T_2) signals were more sensitive to detect differences on meat water drying dynamic that IR (T_1) signals. The greater dehydration of Dry-aged samples promoted differences to the other groups. Using absorber, during the aging process, seems to promote changes on water dynamic towards improving losses. The tenderization did not change drying water dynamic according to the CPMG and IR signals.

ACKNOWLEDGEMENTS

This research was supported by the São Paulo Research Foundation – FAPESP (2022/07950-3; 2020/08845-3; 2019/04221-8; 2021/1269-4 and financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001. The authors would like to thank the National Council for Scientific and Technological Development (CNPq) for providing scholarships support.

REFERENCES

1. Setyabrata, D., Cooper, B.R., Sobreira, T.J.P., Legako, J.F., Martini, S., Kim, Y.H.B. (2021). Elucidating Mechanisms Involved in Flavor Generation of Dry-Aged Beef Loins Using Metabolomics Approach Food Research International 139: 109969.
2. Moraes, T.B., Colnago, L.A. (2022). Noninvasive Analyses of Food Products Using Low-Field Time-Domain NMR: A Review of Relaxometry Methods. Brazilian Journal Physsics 52: 1-9.
3. De Andrade, F.D., Netto, A.M., Colnago, L.A. (2011). Qualitative Analysis by Online Nuclear Magnetic Resonance Using Carr-Purcell-Meiboom-Gill Sequence with Low Refocusing Flip Angles. Talanta 84: 84-88.
4. Kingsley, P.B. (1999). Methods of Measuring Spin-Lattice (T-1) Relaxation Times: An Annotated Bibliography. Concepts Magnetic Resonance 11: 243-276.