Moisture content, water activity, and water populations across different locations within beef (*M. longuissimus thoracis et lumborum*) sections during dry-aging

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Objective: Moisture loss is a key phenomenon which determines the final quality and yield losses of a dryaged product. There is a paucity of research focusing on water dynamics during dry-aging. In this study, different locations within beef sections were stud- ied to investigate: 1) the change in proportion of the three water populations (bound, entrapped, and free) during beef dry-aging; 2) the migration of the three water populations as dry-aging progresses; and 3) the relationship between the LF-NMR data, moisture content and water activity during dry-aging.

Materials and Methods: A steak (5cm) and larger section were excised from each of three bovine LTLs (*M.longissimus thoracis et lumborum)* at 3 days *postmortem*. At 0d of dry-aging, different locations within the 5 cm steak were used for baseline moisture content (MC), water activity (a_w), and NMR T2 relaxation analyses. After 48d of dry-aging [2 °C, 75% RH, air flow range of 0.5-
2.0 m/s, DRY AGER DX 1000® (DRY AGER®, Germany)] the sections were sampled at a number of internal and external (sur- face/crust) locations for MC, a^w and LF-NMR. The data were analysed by means of ANOVA in a randomized block design, with striploins as blocks and the dry-aging location means were compared using Tukey's test at the p <.05 significance level.

Results and Discussion: While a small variation in MC was observed across locations at 0d (5-cm steak), this variation was less than 2%. At 48d dry-aging a small variation was observed in a_w within the external locations, but overall the effect was insignificant. Re- sults suggest moisture was evenly distributed within the crust at 48d of dry-aging. Averaging moisture content within external (35.88 ± 1.57%) and internal (68.90 ± 0.81%) locations, and comparing with in-between (59.28 ± 1.99%) location shows evidence of a moisture gradient and crust formation at 48d. MC and a^w significantly decreased in the internal location from 0d to 48d of dry- aging. Moisture loss has been proposed as contributing factor for developing the unique dry-aged flavour due to the concentration of flavour-related compounds. At 0d of dry-aging, three peaks were identified by LF-NMR. The first peak, bound water (T_{2b}) corre- sponds to water tightly bound to muscle proteins (2.18 - 3.19 ms). The second peak (T_{21}) was immobilized water, which is held within the myofibrils (38.88 - 42.80 ms). The third peak was free water (T_{22}), which can migrate unrestricted within the muscle structure (265.76 - 292.56 ms). At 0d, the distribution of water populations was consistent across locations within the 5cm steak (bound water 1.86 ± 0.34%, entrapped 92.66 ± 1.14%, and free 5.49 ± 0.99%). When 0d and 48d were compared at internal loca- tions, significant differences were observed following dry-aging. Decrease in %free water with dry-aging led to an increase in the relative amount of entrapped water, while %bound did not change after 48d. Moisture decrease observed for internal locations after 48d (from 73.21 ± 0.52 to 68.90 ± 0.81), may be mainly explained due to free water migration from the inner to the external sur- face of the meat, and subsequent evaporation. At 48d, there was no variation in water populations across external locations (bound water 90.71 ± 3.37%, entrapped 8.46 ± 3.11%, and free 0.83 ± 0.75%). The increase in % bound water with respect to internal lo- cations at both 0d and 48d, suggests that relative percentages of entrapped and free water are the most affected by dehydration dur- ing dry-aging. Loss of these two may be facilitated due to weaker chemical interaction with meat matrix. An increase in relaxation time was detected for all components. Increases in T_{2b} time may be related to a decrease in bonding capacity between protein and water due to protein denaturation (McDonnell et al., 2013); whereas increases in T_{21} and T_{22} times reveal a more mobile water pos- sibly due to structural changes in the meat (Pearce, Rosenvold, Andersen, & Hopkins, 2011).

Conclusions: Data was generated on internal and surface water populations and moisture content as a result of dry-aging, which deepens our knowledge of the mechanisms influenced by this process. Expanding this research to include assessment of overall fla- vour development can help to identify the minimum yield loss required to achieve a perceptible overall flavour improvement dur- ing dry-aging

References:

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Key words: LF-NMR, Water activity, Dry-aging, Beef