Dry-aging beef: dehydration dynamics in varying meat geometries

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Introduction: Dry-aging is a traditional process of extended aging of beef under defined refrigeration, humidity and air speed conditions, with the aim of improving meat quality attributes, in particular tenderness and flavour. Concentrating flavour-related compounds as a result of moisture loss during dry-aging, is known to be a key process for the development of a unique flavoured dry-aged beef product (Dashdorj et al., 2016). There is a paucity of literature on drying dynamics during dry-aging; understanding this process could aid optimisation of aspects such as economic loss due to evaporative and trim loss, and resultant meat quality. Thin-layer models have been typically employed to assess the drying behaviour of several agri-food products (e.g. grains, fruits and vegetables), with some examples using beef slices (Başlar et al., 2014). In applying most thin-layer models, geometry is decisive and thickness of the product is kept as small as possible, so air conditions can be assumed constant while the air is passing over the food layer (Wang et al., 2004). The aim of this work was to study the dehydration kinetics during dry-aging across different meat geometries as this may impact the drying rate, as well as, some meat quality traits.

Materials and methods: Three meat geometries (slices, steaks and sections) were obtained from three striploins, each one from a different animal, at 3 days post-mortem and dry-aged at 2.0 °C, 75% relative humidity and fixed air flow. Weight loss was recorded during dry-aging using a digital balance. Slices and steaks were weighed until no further changes were observed (i.e. when the equilibrium moisture content (Me) had been achieved, at 22 and 49 days, respectively). Sections were aged for 48 days and Me was estimated for this geometry. The drying curves, i.e. moisture content (dry weight basis, (dwb)) versus time, were plotted to visualise the curves. Additionally, data from slices and steaks was fitted to seven thin-layer equations in order to model the drying kinetics during dry-aging. Compositional analysis of the samples were also performed.

Results: An exponential decrease in moisture content (Mt) is evident over time in all 3 geometries. As expected, larger geometries took longer to achieve the equilibrium moisture content (Me). For slices, Me=0.20 g/g dwb after 22 days of dry-aging, for steaks Me= 0.53 g/g dwb after 49 days and for sections, Me was estimated to be 1.404 g/g dwb and achieved after 232 days. Briefly, the most appropriate model to describe the drying kinetics during dry-aging of slices and steaks was the Midilli model (MR=a exp(-ktn) + bt). The parameter k represents the drying rate constant (units: h-1) and refers to the rate of moisture loss from the sample (Perea-Flores et al., 2012). Steaks showed a slightly lower k value than slices, meaning they are dried at a lower rate. Compositional data showed the moisture loss from start to end of dry-aging and resulting impact on concentrating protein, fat and ash contents.

Conclusion: Drying curves during dry-aging have been demonstrated for 3 geometries with larger sections showing limited dehydration due to moisture migration from the core to the surface of the piece. Thin-layer equations can be used to describe the drying kinetics of small-sized samples; with reduced k values (h-1) seeming to be in agreement with lower drying rates as thickness increased. These equations are not suitable to model the drying kinetics of sections, since additional geometric dimensions, and hence, alternative mathematical approaches must be considered. It is of relevance to understand the drying kinetics during dry-aging of beef, as this can help in optimizing economics losses associated with dry-aging.

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