Optimization of chicken breast cooking through a kinetic study on quality indices modifications

Giulia Romano [1,2], Maria Cristina Nicoli [1], Arianna Bozzato [2], Daniele Turrin [2], Monica Anese [1]

[1] University of Udine, Udine, Italy, [2] Electrolux Professional SPA, Pordenone, Italy

Objectives: In food service, meat is one of the most requested items and accounts for a significant percentage of the total cost of production. Oven cooking is the most frequently used cooking process for meat in commercial processing and foodservice operations because it facilitates a high volume of foodstuffs to be cooked at the same time in a controlled way.

An optimal meat cooking process should firstly ensure safety of meat at point of consumption through pathogen inactivation and also facilitate the development of desirable sensory attributes, while maintaining technological performance e.g. in terms of adequate cooking yield and hardness. During cooking, meat undergoes major chemical and physical changes which influence final quality and consumer acceptability. Several parameters related to the oven such as temperature, relative humidity, cooking time can affect the final quality of cooked foods. Kinetic modelling of the evolution of quality indices of product during cooking represent a powerful tool for understanding the evolution of quality attributes as they change during the cooking process, for predicting out- comes and to permit optimization of the cooking process (Ling et al., 2015).

Poultry meat is the most consumed meat in the world for its high nutritional quality, low religious barriers and cost effectiveness (OECD, & FAO, 2021). While it is imperative to achieve a final internal cooked meat temperature of 75 °C, chicken is easily susceptible to drying and overcooking. The aim of this study was to investigate the evolution over cooking time of several quality in- dices of chicken breast cooked according to different cooking methods and temperatures.

Materials and Methods: Thawed chicken breasts were cooked individually in the centre of a vessel in an electric oven according to three different cooking methods and three different cooking temperatures. The tested cooking processes were:

- forced convection (FC): 150, 170, 190 °C for increasing times up to 38 min;
- grill (G): 240, 260, 280 °C for increasing times up to 19 min;
- sous vide (SV): 80, 95, 120 °C with 100% humidity for increasing times up to 35 min.

For each cooking method, the employed cooking times included the optimal time of achievement of 75 ºC at the core and 2 over- cooked times beyond this. In the complex, fillets were cooked for 15 different cooking times (5 cooking times for each tempera- ture) within each cooking process and all experiments were replicated three times. At each cooking time, samples were weighed, analysed for texture and colour measured. Evolution of weight loss, shear force and chroma were studied using kinetic models and zero order constant rates were extrapolated. Decimal reduction time (D_T) and activation energy (Ea) of quality indices modification were calculated.

Results and Discussion: Cooking loss, shear force and colour zero order rate constants were monitored over the cooking process. A proportional increase of rate constants was observed according to process temperature, independently of the considered cooking method. The treatment characterized by the highest process temperature (G) showed the fastest quality indices evolution, followed by FC and SV. Temperature was able to accelerate all the physical and chemical changes within the meat. Firstly, protein denaturation accelerates, enhancing loss of water and weight loss, then collagen solubilization also improves, determining a fastest de- crease in softness during cooking and last, a faster Maillard reaction darkens meat for highest temperatures. For SV no colour changes were seen during cooking, due to the characteristic low temperatures and high humidity of this process (Yu et al., 2016)]. D_T values of the considered quality indices were calculated. D_T decreased at increasing process temperature for all the different cooking methods. G showed the lowest D_T values, followed by FC and SV. Among the quality indices, shear force always exhibited the highest D_T, the highest value was 108 min at 80 °C for SV, while cooking loss the lowest one, 11 min at 280 °C for G.

Ea values were in the order of magnitude of 20-65 $kJmol^{-1}$. A dependence of Ea on temperature was found. Shear force showed the highest value for all the treatments, with a maximum of 65.45 $kJmol^{-1}$ for G. Cooking loss showed instead the lowest values, 20.50 $kJmol^{-1}$ for FC, confirming to be the most sensitive indicator to temperature change.

Conclusions: Proportionality of kinetic parameters indicates the possibility of modelling the cooking process. Identification and con- trol of the most sensible quality index can drive the optimization of cooking allowing a better management of the industrial cook- ing process.

References:

Ling, B., Tang, J., Kong, F., Mitcham, E. J., & Wang, S. (2015). Kinetics of Food Quality Changes During Thermal Processing: a Re- view. *Food and Bioprocess Technology*, 8(2), 343-358.

Yu, T., Morton, J. D., Clerens, S., Dyer, J. M. (2016). Cooking-Induced Protein Modifications in Meat. *Comprehensive Reviews in Food Science and Food Safety*, 00, 1-19.

OECD/FAO (2021), *OECD-FAO Agricultural Outlook 2021-2030*, OECD Publishing, Paris.

Key words: Kinetics, Modelling, Quality indices, Cooking process, Chicken breast