COOLING OF MEAT PRODUCTS AND FOOD SAFETY

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Background

There were a lot of changes in the field of heat treatment of the cooked sausages. On the contrary the control of safety limits not so clear as in the case of Cl. botulinum. Beside the use of the correct EPT (equivalent pasteurisation time) units (INCZE et al. 1999) the core temperature and mm/min principles exist and they are in use in the practice although the ISO, HACCP, TQM systems and food safety would require an accurate and reproducible control measures. The case is more complicated because of the development of the cooking chambers (circulating patterns, higher and several velocities) and spreading new cooling technology (still water, shower, spray nozzle, evaporative cooling, vacuum cooling) both in the chamber and in separate unit. Moreover we can often experience fluctuating mass flow and temperature of cooling media. Therefore people treat cooling as safety overprocessing factor.

Objectives

Our aims was to investigate the most widely used shower system

- Th effect of the cooling parameters on the cooling time, EPT value.
- How can be divide the EPT between cooking and cooling?
- Effect of fluctuating/uneven mass flow and changing temperature of cooling media

Materials and methods

We analysed a 90 heat penetration curves and determined the thermal diffusivity from it with Ball method (RAMASWAMY 1982). The thermal diffusivity was determined by the composition as well (RIEDEL 1969). The temperature dependence was taken into account on the base of the average temperature during the process stage.
The surface heat transfer coefficient were determined with lumped capacity method, Nusselt functions (WONG 1983, LYDERSEN 1982) and non linear least squares estimation of the infinite series solution of the Fourier partial differential equation. On the base of the determined and surveyed heat treatment parameters we calculate different processesaccording to the experimental design (DEÁK and KEMÉNY 1991).

Results and discussions

The surface heat transfer coefficient ranges for the different cooling systems were about 60, 150, 200, 400 W/m^{2}K, for the still water, older equipment wet air circulation, shower falling film and newer equipment respectively. The thermal diffusivity was about 1.3-1.4E-7 m^2/s average values.
Regarding to the cooling time the products ca be divided into two subgroups. The d=50 mm diameter is the dividing line. Under this the cooling circumstances, the surface heat transfer coefficient, the initial cooling temperature and cooling water temperature has only a minor role, meanwhile if d>50 mm these circumstances influence the cooling more and more pronounced. The cooling time can be greatly reduced till Bi=5 and Bi=20 for d<50 mm and d>50 mm respectively. After that there only a small, maximum several minutes, lowering can be achieved in cooling time.
Regarding the food safety, the meat products had a fully opposite behaviour according to the diameter. Under 50 mm diameter the cooling can be considered as a safety factor (only 1-3D of lethality cumulated during the cooling). At d=65 mm 3-5 D lethality, at d=83 mm 6-9D lethality and d=105 mm 12D lethality can be achieved according to the initial cooling temperature and Biot number.
The cooling water temperature plays role mainly in the upper region (above 15°C), meanwhile in the lower region there is no need to invest too much in lowering the cooling water temperature. The shortening is only several minutes in case of 5°C vs. 2°C. The fluctuating temperature is (winter and summer) is more pronounced in higher range of temperature above 15°C. The influence of the mass flow rate (surface heat transfer coefficient and Biot number) and fluctuating temperature can produce about 5-10 °C difference but in EPT it may be as many as 10-15 minutes depending on size and core temperature at the steam off.
From the results can be seen that it would be worthy to differentiate between the products in cooling, even in cooking, phase according to the size of the product. In case of using average values the small sizes (frankfurter) consume too much energy. The small sizes can be cooled quicker and cheaper with temperature lowering, meanwhile as oposite true in case of larger diameters.
Even if we can reach a quicker cooling with evaporation the determining factor is the thickness, the diameter of the product. In this way we can reach rather water sparing and not temperature fall in the product. We can follow two kind of strategies. First the cooling of the product planned for the thickest product and correcting it by the cooling water temperature for speeding up the cooling. Secondly we invest several thousand EURO for frequency converter for regulating the ventilators individually fort he products (note control the heat exchanger part as well!) and using only the maximum necessarily amount of electric energy for circulating the air.
We can assume according to our results we can assume the following ratio between the cooking and cooling phase: frankfurter 90:10, liver sausage (d=40 mm) 80:20, cooked sausage (d=65 mm) 70:30, cooked sausage (d=83 mm) 60:40, cooked sausage (d=105 mm) 50:50. Nevertheless we can re-scale the cooking or the hot-smoking and cooking phase as well because it works in an analogue way.

Litrerature

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